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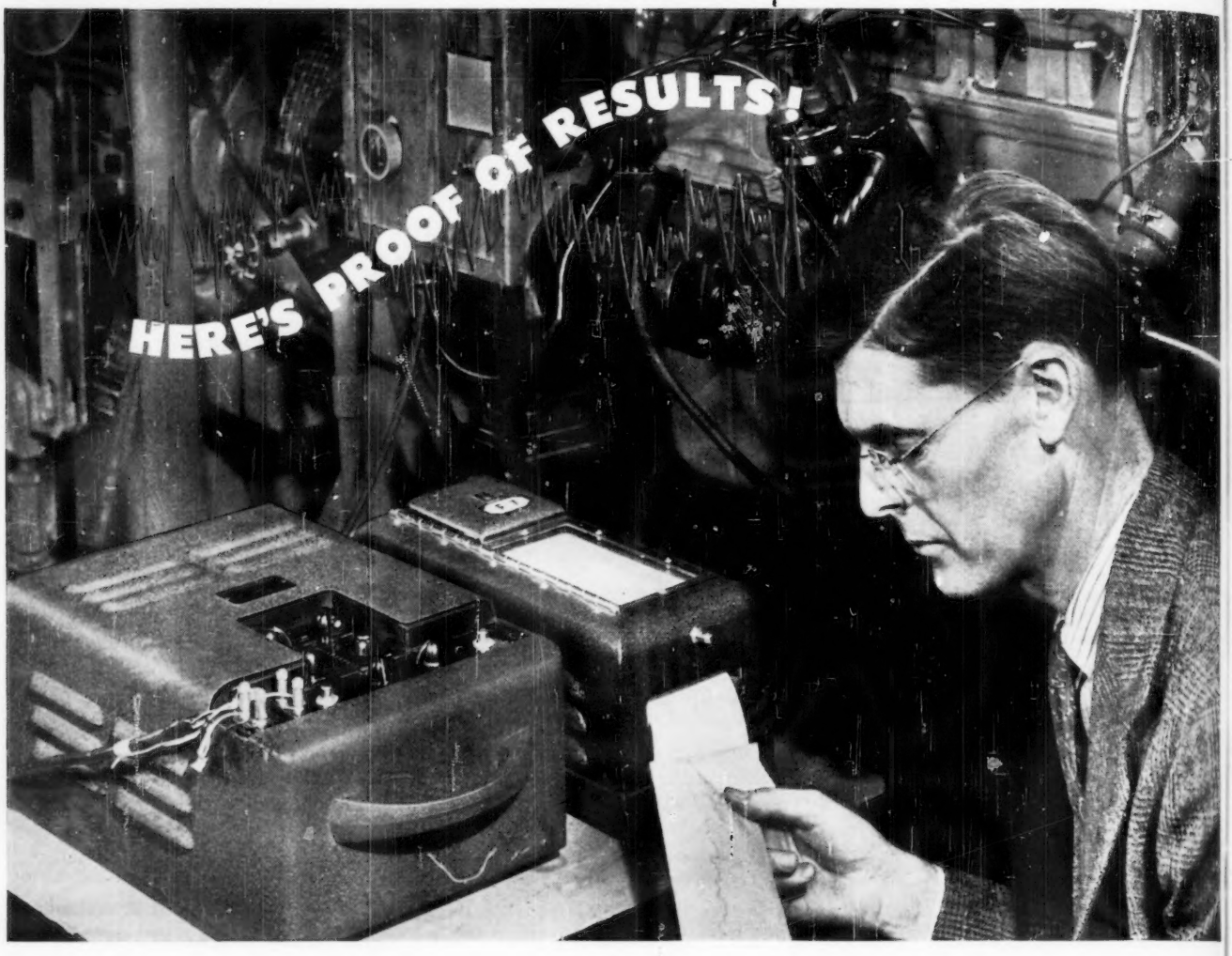

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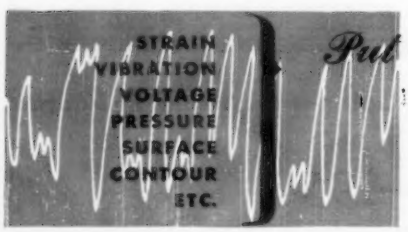

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ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

TELEPHONE—Rittenhouse 6-5315

R. E. Hess, Editor
R. J. Painter, Associate Editor

CABLE ADDRESS—TESTING, Philadelphia

Number 165 APRIL, 1950

260 Meetings During ASTM Committee Week

Panel Discussion on Colorimetry in Paint Field—Conference on Radioactive Isotopes in Testing

IN SPITE of the coal strike with some of its threats already taking effect, such as local "brownouts" and curtailment of train and other transportation and electric services, a registration of just short of 1000 was recorded at the A.S.T.M. Committee Week in Pittsburgh beginning February 27. This good attendance was reflected in the holding of 260 separate meetings of the various technical committees and their subdivisions, many of which had overflow attendance of members and visitors.

It would be difficult to single out any one outstanding feature of Committee Week. Primarily it is a time in which a good proportion of the technical committees of the Society meet, especially the subcommittees, and attempt to crystallize and finalize long series of research projects and round-robin tests leading up to the formulation of A.S.T.M. standards. By taking subcommittee action at this time, there is opportunity to secure confirmation by committee letter ballots and to incorporate recommendations on new and revisions of old standards into the annual report of the committee for presentation at the Annual Meeting in June. Some of the recommendations covering new standards, however, may be presented to the Administrative Committee on Standards prior to this time.

Two or three events might be cited which were of considerable interest and somewhat apart from the routine schedule of committee meetings. A conference on radioactive isotopes was held on the evening of March 2 to determine the interest in establishing an A.S.T.M. committee on the use of radioactive isotopes in testing. This attracted a good audience. A further item on this conference will be found elsewhere in the BULLETIN.

A panel discussion on colorimetry was held under the auspices of Committee D-1 on Paint, Varnish, Lacquer, and Related Products, at the conclusion of

Outstanding Annual Meeting Developing

June 26–30, Atlantic City

IN ADDITION to a large number of technical papers and reports —many of the papers to be presented as parts of symposiums or special technical sessions—the 1950 Annual Meeting, the Society's fifty-third, will also feature an interesting entertainment program being developed by the Philadelphia District. Throughout the week of the meeting, the Ninth Exhibit of Testing Apparatus and Related Equipment will be in progress and the Seventh Photographic Exhibit. Some details of the two exhibits and the 1950 Edgar Marburg Lecture on Spectroscopy appear later in this BULLETIN.

Early in April there is being distributed to each member and committee member by a special circular letter an outline of the Annual Meeting features and times at which committee reports will be presented. This information and the Hotel Reservation Return Form that will accompany it will give those planning to attend an opportunity to make hotel reservations. A heavy attendance of members and visitors is expected and members are urged to return the hotel form as early as possible. Provisions have been made for adequate hotel facilities—although as always there will be a very limited number of single rooms.

Technical Features:

Full details of the technical features and other phases of the meeting will appear in the May BULLETIN to go in the mails the last week of that month. This will feature the Provisional Program with complete lists of papers and reports and synopses of most of the papers.

Subjects to be covered in symposiums or sessions or groups of technical papers include the following:

Effect of Sigma Phase on the High Temperature Properties of Metals
Corrosion of Gas Turbine Materials
Methods of Testing Soils Under Triaxial Loading
The Role of Non-Destructive Testing in the Economics of Production
Identification and Classification of Soils
Effect of Temperature on Metals

Plastics, fatigue, cement, and concrete, aggregates, adhesives, wood fiber pulps, antifreeze, synthetic sea water, radiography, thermal conductivity, ferrous and non-ferrous metals

their meetings. Mention of this will be found in the following articles on committee meetings.

A list of the committees which met in Pittsburgh is shown. There appears on the following pages an account of the major items of interest which transpired at these meetings.

For the most part all of the recommendations noted will be referred to the various committees for letter ballot before formal recommendation to the Society, and this situation should be kept in mind in reviewing the proposed actions. Members will be given further information through the preprints of reports which will be distributed this year, as previously, in advance of the Annual Meeting, these reports covering the many actions which committees will bring up at the Annual Meeting in Atlantic City, June 26–30.

Several other A.S.T.M. Technical Committees have held meetings in the past few weeks and because of this and other reasons did not meet in Pittsburgh. A news account of these meetings appears with the statements of groups which met in Pittsburgh.

List of Committee Meetings

A-1 on Steel
A-3 on Cast Iron (Subcommittees)
A-5 on Corrosion of Iron and Steel
A-7 on Malleable-Iron Castings (Subcommittees)
A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys
B-1 on Non-Ferrous Metals
B-3 on Corrosion of Non-Ferrous Metals
B-4 on Electrical Heating, Resistance, and Related Alloys
B-5 on Copper and Copper Alloys
B-6 on Die-Cast Metals and Alloys
B-7 on Light Metals and Alloys
B-8 on Electrodeposited Metallic Coatings
C-1 on Cementitious, Ceramic, Concrete, and Masonry Materials
C-7 on Lime
C-8 on Refractories
C-9 on Concrete and Concrete Aggregates
C-16 on Thermal Insulating Materials
C-21 on Ceramic Whitewares
C-22 on Porcelain Enamel
D-1 on Paint, Varnish, Lacquer, and Related Products
D-2 on Petroleum Products
D-3 on Gaseous Fuels
D-4 on Road and Paving Materials
D-5 on Coal and Coke
D-6 on Paper and Paper Products
D-8 on Bituminous Waterproofing and Roofing Materials
D-11 on Rubber and Rubber-Like Materials
D-15 on Engine Antifreezes
D-16 on Industrial Aromatic Hydrocarbons
D-18 on Soils for Engineering Purposes (Subcommittees)
D-19 on Water for Industrial Uses
E-1 on Methods of Testing
E-2 on Emission Spectroscopy
E-4 on Metallography
E-5 on Fire Tests
E-7 on Radiographic Testing (Advisory)
E-9 on Fatigue

A-1 on Steel:

(*Philadelphia—Jan. 30*)

For several years Committee A-1 on Steel has recognized the need for mechanical testing manuals for the various fields of steel products. Much effort has been spent in preparing such manuals and several are now almost complete. It is intended that each be published separately. Then the various manuals will finally be combined in one document. The manual for bar steels is now being reviewed by Committee A-1 and probably will be the first to be published. This will be followed by one covering tubular products and another on sheet and strip. Also under way are manuals for structural steel and for steel for boilers and pressure vessels. The status of these manuals was reported upon at a series of meetings of the Committee in Philadelphia from January 30 to February 1.

In 1949 the Society published a special pamphlet including the ten specifications for structural steel written by Subcommittee II of Committee A-1 on Steel including the new General Requirement Specification A 6. A new specification for steel sheet piling for dock walls, sea walls, cofferdams, excavations, and like applications probably will be issued in 1950. Revisions are contemplated in Specifications A 94 for Structural Silicon Steel and A 284 for Silicon Steel for Machine Parts and General Construction. In view of the new specification for steel sheet piling, a revision of the general requirement specification A 6 is necessary—tolerance tables and other general requirements covering sheet piling will be added. Several of the other tolerance tables in A 6 will be revised in line with current practice. The yield point and elongation requirements in all the structural steel specifications have been reviewed and correlated so that definite figures will be included in place of the old sliding scale figures. With the incorporation of these revisions, structural steel specifications will be advanced to the status of standard with the exception of A 131 covering ship steel, on which work is in progress.

Subcommittee VI on Steel Forgings has been working for three years on the several specifications under its jurisdiction, and late in 1949 the up-to-date versions were finally approved by the Society. They will appear in the 1949 Book of A.S.T.M. Standards, Part 1. The two specifications for billets, blooms, and slabs for forgings (A 273 for carbon steel and A 274 for alloy steel) are now being reviewed.

A need for a standardized method for ultrasonic testing of forgings is under careful study in the subcommittee. Also being drafted is a proposed specification covering alloy steel forgings for pressure vessels.

Subcommittee VII on Rolled Steel Wheels and Steel Tires has reviewed the specifications under its jurisdiction and found them to conform to present commercial practice without revision. However, a new specification for heat-treated carbon-steel tires for railroad use will be presented to the Society.

In the castings field, a new specification for steel castings for steam turbine casings has been written by Subcommittee VIII, and reviewed, and is expected to be published in 1950.

In Subcommittee XI covering steel for boilers and pressure vessels, a new specification covering 1 per cent chromium, ½ per cent molybdenum steel plate is being drafted.

The work in Subcommittee XV on Bar Steels is considered from now on to be a matter of revision and refining its present specifications. During the past several years, this subcommittee has written many new specifications for grades of bar steel which had not previously been covered by A.S.T.M. A new tentative for cold-finished alloy-steel bars which will finish the coverage of the field of bar steels is in its final stages and will soon be presented to the Society for publication.

In 1949 Specifications A 157 – 44 for Alloy-Steel Castings for Valves, Flanges and Fittings for High-Temperature Service, and A 217 for Alloy-Steel Castings Suitable for Fusion Welding for High-Temperature Service were consolidated into a new specification, A 217 – 49 T, covering ferritic grades. Since several austenitic grades were included in A 157 – 44 there is a need for a new specification covering these new grades and a group has been appointed to draft such a document.

In 1949 a tentative revision of Specifications A 234 for Factory-Made Wrought Welding Fittings was published which included the 1 per cent chromium, ½ per cent molybdenum grade of material. It is proposed to include this tentative revision in the body of the specification. Committee A-1 recognizes that there is a need in industry for a specification for stainless steel welding fittings to be used in conjunction with stainless steel pipe.

In Specification A 193 for Alloy-Steel Bolting Material for High-Temperature Service, it is proposed to delete grades B 4, B 11, B 12, B 13, and B 15, in view of the fact that the tonnage of steel produced to these grades seems to be very small or nonexistent. Also in

Specification A 320 for Low-Temperature Bolting Materials, the section on nuts and washers will be revised to clarify further the grades of nuts which should be used with the various alloy bolting steels covered by the specification.

A new specification is under way for fusion welded alloy-steel pipe for high-temperature service. There is demand for this type of pipe in central power station installation for reheat and main steam lines of large sizes and heavy walls to eliminate the need for forged and bored pipe which is very expensive. Several alloy grades of compositions now prevalent in high-temperature use would be included, such as $\frac{1}{2}$ per cent chromium; $\frac{1}{2}$ per cent molybdenum, 1 per cent chromium; $\frac{1}{2}$ per cent molybdenum, $2\frac{1}{2}$ per cent chromium; and 1 per cent molybdenum.

Several important changes are proposed in Tentative Specification A 325 for Quenched and Tempered Steel Bolts and Nuts, which was first issued in 1949. The minimum tempering temperature has been lowered from the previous 800 F. to 700 F. The present tension test, plastic deformation test, and head test are being replaced by a single test called the "Wedge Test." This consists of conducting a full size tension test except that a 10-deg. wedge is placed under the head of the bolt. During the test, failures must occur in shank or the threaded section and not at the juncture of head and shank. The load at which failure occurs must meet the respective minimum tensile load required. It is proposed also that the marking for quenched-and-tempered grade of bolt shall be three radial marks on the head of the bolt in addition to the manufacturer's identification.

Specification A 312 – 48 T for Seamless and Welded Austenitic Stainless Steel Pipe is being revised to make it more satisfactory for use under the A.S.M.E. Boiler Construction Code. Among other revisions, supplementary requirements will be added including transverse tension tests, flattening tests, etching tests, and statement that when formed by fusion welding, the procedure and the operators shall be qualified in accordance with the A.S.M.E. Boiler Construction Code. In addition, two new grades will be added to the specification, including types 309 and 310.

A-5 on Corrosion of Iron and Steel:

Subcommittee VII on Methods of Testing has been investigating various methods for testing coatings. They have investigated the magnagage, radioactive isotopes, electronic gage, Preece test, and the Hull-Strausser dropping test. Present results seem to indicate that a variation of about ± 10 per cent can be expected in the magnagage, that the use of radioactive isotopes is effective on coatings over 0.01 in. in thickness, and that the Hull-Strausser dropping test, while not accurate, will give a quick approximation. These investigations are continuing.

A task group has been appointed in Subcommittee XI on Sheet Specifications to study the possibility of developing coating bend tests for No. 12 and 14 gage material in Specification A 93 for Zinc-Coated Iron on Steel Sheets. This same group will investigate the possibility of specifying a bend test for Class D material in this same specification. There was considerable discussion as to the advisability of developing a separate specification for $1\frac{1}{4}$ oz. weight of coating roofing sheets or whether this should be included in Specification A 93.

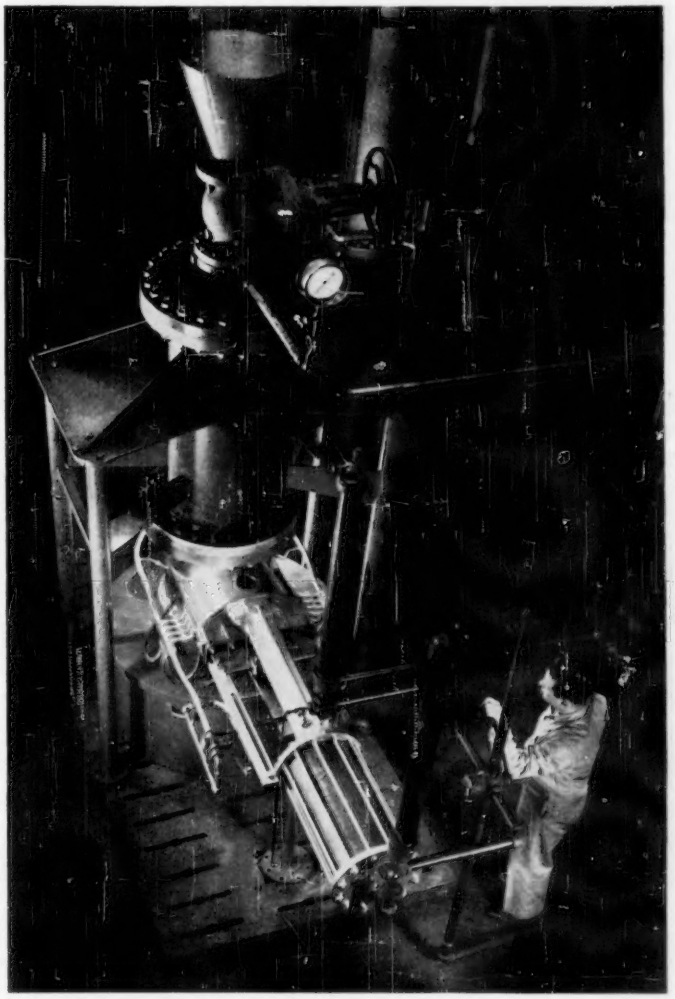
Specification A 267 for Lead Alloy Coating (Hot-Dip) on Iron or Steel Hardware will be recommended for adoption as standard. (Subject to letter ballot.)

The usual inspection trips covering both wire and sheet exposure tests will be made during the month of April.

A-10 on Iron-Chromium-Nickel and Related Alloys:

One of the most important developments in the meeting of Committee A-10 was the report of Subcommittee VI on Metallography. This subcommittee has been conducting studies of sigma phase identification in stainless steels. Extensive data have been collected from Charpy impact tests and metallographic examinations. At the meeting of Subcommittee VI to be held in Atlantic City at the time of the Annual Meeting in June, the identification of sigma phase will be discussed extensively. The discussion will be aided by the projection of numerous photomicrographs, both black and white and in color. Anyone interested in this study is invited to attend.

A member of the committee, Russell Franks, commented that new or revised specifications will have to be considered for the high-temperature steels and type 347. This is due to the fact that ferrocolumbium supplies are decreasing and may become nonexistent. The ferrocolumbium now being used (approximately 55 per cent columbium, 5 per cent tantalum) will have to be replaced



"Simulated Service Test on Large Valves"

First prize-winning photograph, General Section, Simulated Service Testing Group, in the Sixth A.S.T.M. Photographic Exhibit (1948), by William W. C. Wilke, Jr., Crane Co. Research Laboratories.

by ferro-tantalum-columbium containing approximately 20 per cent tantalum and 40 per cent columbium. This will necessitate specifications that will take into account the addition of tantalum.

It was agreed to act upon a request for specifications for centrifugally cast alloy iron pipe and to seek the cooperation of Committee A-1 on Steel in this matter as has been done in the consideration of specifications for seamless tubing, which work is progressing satisfactorily. Committee A-10 has also made minor changes in Specification A 276 for Hot-Rolled and Cold-Finished Corrosion-Resisting Steel Bars (subject to letter ballot) and is considering revisions in Specification A 240 for Corrosion-Resisting Chromium and Chromium-Nickel Steel Plate, Sheet, and Strip for Fusion-Welded Unfired Pressure Vessels.

B-1 on Wires for Electrical Conductors *(Philadelphia—Jan. 20)*

While the committee had pretty well cleared its docket of matters pending in its report to the Society last year in anticipation of the new Book of Standards, nevertheless Committee B-1 on Wires for Electrical Conductors held a most interesting two-day meeting at Society Headquarters on January 19 and 20. The meetings were in the charge of W. R. Hibbard, Vice-Chairman (J. H. Foote, Chairman, was unavoidably absent), and of the Secretary, A. A. Jones. A number of task groups were appointed to take in hand specific assignments. For example, it is proposed to reactivate the matter of specifications for tinned medium-hard and hard wire. There was also a question of tolerances for hot-rolled copper rods (B 49) and the development of a suitable gage for measuring trolley wire (B 9).

Progress was reported on the development of specifications for segmental conductors as well as on a number of proposals for modifications of existing specifications.

B-3 on Corrosion of Non-Ferrous Metals and Alloys:

Dr. T. P. May presented a progress report on his study of the effect of (1) natural sea water, (2) synthetic sea water, (3) 3 per cent NaCl solution, and (4) 20 per cent NaCl solution, on various metals and alloys. His report was illustrated by numerous color slides of specimens exposed in each corrosive media.

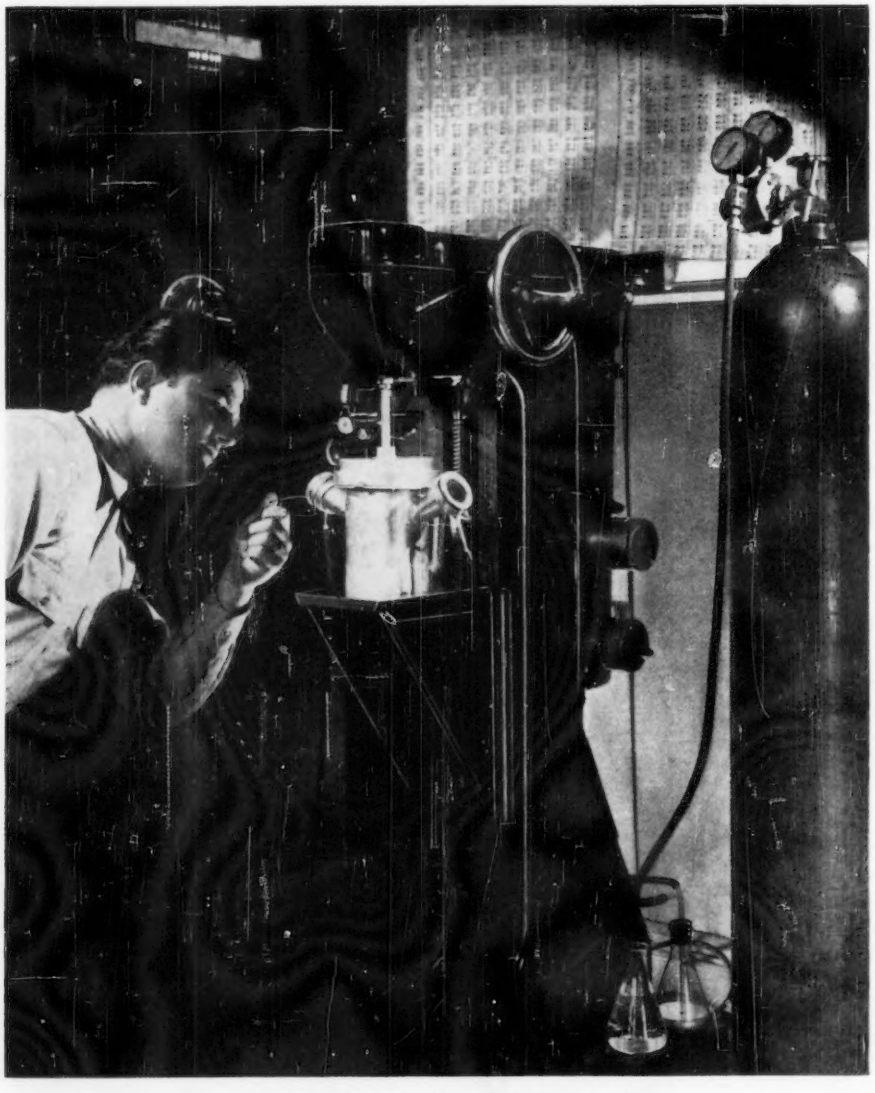
Subcommittee III on Spray Test reported progress on its study of a 1 per cent glacial acetic acid—salt spray test for testing plating on zinc-base die castings. This subcommittee expects to have a definite recommendation at the next spring meeting. The present salt spray method will be continued as tentative.

In view of the fact that Subcommittee IV on Humidity has been without a chairman for more than a year, it was agreed that the subcommittee should be discharged and it was agreed that the Advisory Committee on Corrosion should transfer the responsibility for humidity testing to a committee with a more definite interest, although Committee B-3 would wish to have representation on this humidity testing committee.

The test specimens at La Jolla were removed last fall, and it was agreed that the tests, although having run only 18 years of the proposed 20 years, should be officially discontinued.

Subcommittee VII on Weather is continuing its tests of the corrosivity of various atmospheres as shown by weight loss of iron and zinc specimens. There was considerable discussion in this subcommittee on the subject of air pollution, and the subcommittee would like to work with other committees or organizations interested in this field.

Subcommittee VIII on Galvanic and Electrolytic Corrosion reported that disk-type galvanic couples have been exposed in New York, Kure Beach, and the Canal Zone and that those at State College will be exposed in the near future. Part 2 of this subcommittee's program, which concerns the spool-type specimen, is about ready for exposure, and when the preparation of these spool-type specimens has been completed, work will be initiated on Part 3 of the program, the plate-type specimen. The



"Vickers Hardness Test on Hot Metals"

Honorable Mention, Testing Equipment Group, General Section, in the Sixth A.S.T.M. Photographic Exhibit (1948), by William W. C. Wilke, Jr., Crane Co. Research Laboratories.

present iron couples which have been on exposure for nine years will be removed as soon as possible. The remaining couples will be kept on exposure for an additional six years, or a total of 15 years.

B-4 on Electrical Heating, Resistance, and Related Alloys (*Philadelphia—March 1*)

Committee B-4 on Electrical Heating, Resistance, and Related Alloys met at A.S.T.M. Headquarters on March 1 and 2. A number of tentative specifications are being considered by the various subcommittees for recommendation for advancement to standard at the time of the Annual Meeting. About a dozen new standards will be made available soon to the industry through the work of this committee.

Particularly active are the subcommittees on high-temperature alloys, corrosion problems at high temperatures, materials for radio tubes and incandescent lamps such as cathodes and tungsten parts, and the group on Electrical Contacts. While these different subcommittees are working in different fields, it is interesting to note that each in its own committee is sponsoring a program for standard testing methods and one on related research problems, the answers to which are required before standard test methods can be developed. The research and test results are fully as important as the subsequent standard test procedures which result from this work.

B-5 on Copper and Copper Alloys: (*Philadelphia—Jan. 25*)

Because of its activity in specifications work, Committee B-5 regularly finds it necessary to meet twice previous to an Annual Meeting to prepare its recommendations.

Closer straightness tolerances for slit metal are recommended in eleven specifications covering copper and copper-alloy plate, sheet, and strip, including the following:

A.S.T.M. Designation	Material
B 19 – 49 T.....	Cartridge Brass
B 36 – 49 T.....	Brass
B 97 – 49 T.....	Copper-Silicon Alloy
B 103 – 49.....	Phosphor Bronze
B 121 – 49 T.....	Leaded Brass
B 122 – 49 T.....	Copper-Nickel-Zinc and Copper-Nickel Alloy
B 130 – 49 T.....	Gilding Metal
B 152 – 49 T.....	Copper
B 169 – 49 T.....	Aluminum Bronze
B 194 – 49 T }	Beryllium Copper
B 195 – 49 T }	

Specifically recommended is a revision of the mechanical property requirements in Specifications A 194 and A 195 for Beryllium Copper Plate, Sheet, and Strip, and a revision of chemical requirements in Specifications B 121 for Leaded Brass Plate, Sheet, and Strip, including addition of an Alloy 5 with nominal composition of 65.0 per cent copper, 2.0 per cent lead, and 33.0 per cent zinc.

The Subcommittee on Plate, Sheet, and Strip is continuing a study of the requirements for bars sawed or cut from plates, the use of Rockwell hardness as a mandatory requirement, and the addition of phosphor bronze Alloy B-2 (now in Specifications B 139 for Rods, Bars, and Shapes) to Specifications B 103 for Plate, Sheet, and Strip.

The Subcommittee on Rods, Bars, and Shapes is continuing the study of inclusion of additional size ranges to Specifications B 133 for Copper Rods, Bars, and Shapes, and the collection of Rockwell hardness data for possible inclusion in specifications. It is also studying revision of mechanical properties in Specifications B 196 for Beryllium Copper Rods and Bars and the possibility of specifications for copper-alloy forgings.

Requirements for automotive and refrigeration tube are being developed and Rockwell hardness requirements are being reviewed in all the pipe and tube specifications. In Specifications B 135 for Seamless Brass Tubes consideration is being given to the addition of requirements for 90–10 copper-zinc alloy. The dimensional tolerances in Specifications B 111 for Seamless Condenser Tubes are undergoing thorough study.

Specific recommendations for pipe and tube products include the revision of the present iron limit of 1.0 per cent max. (in Specifications B 111) to a range of 0.5 to 2.0 per cent, and also a revision of Specifications B 88 for Seamless Copper Water Tube in accordance with Simplified Practice Recommendation R 217 – 49 for Copper Water Tube and Copper and Brass Pipe issued by the U. S. Department of Commerce.

Several changes are recommended for specifications covering wire products including a revision in tensile requirements in Specifications B 197 for Beryllium Copper Alloy Wire and a lowering of the lot size for chemical analysis in specifications B 134 for Brass Wire.

The Subcommittee on Methods of Test is continuing its study on the effect of speed in tension testing. It has recommended a revision in the scope clause of Method B 154 for Mercurous Nitrate Test for Copper and Copper Alloys, limiting the applicability of the method to determining the presence of residual (internal) stress which might result in season cracking and is devoting study to a further revision of the method.

Committee B-5 is also considering the possible addition of requirements for certain impurities in its specifications covering brass products. Possible envelope specifications for dimensional tolerances and the significance of dimensional tolerances are being studied.

B-6 on Die-Cast Metals and Alloys:

Subcommittee I on Aluminum-Base Die Casting Alloys has completed studies showing that within certain limits varying amounts of zinc in aluminum alloys containing 8 per cent silicon and 4 per cent copper have no deleterious effects on the mechanical properties. This subcommittee is, therefore, submitting to letter ballot of the committee changes in zinc limits of Alloys SC5 and SC6 in A.S.T.M. Specification for Aluminum-Base Alloy Die Castings (B 85) to change the maximum zinc limits from 0.6 to 1.0 per cent.

The data on the 10-year exposure tests of zinc and magnesium alloys will be reported in the near future. One set of zinc and magnesium alloys will be exposed for another 10 years which will give a total elapsed exposure time of 20 years. These specimens are exposed in eight locations.

There was considerable discussion during the meeting on the suggestion that Committee B-6 adopt the codification of aluminum and magnesium alloys used by Frankford Arsenal and recently adopted by Committee B-7.

A special group was appointed to investigate work being done at Columbia University on flow of heat in die castings and on the possibility of suggesting that A.S.T.M. cooperate in this research program.

The Tentative Specification for Copper-Base (Brass) Alloy Die Castings (B 176) will be submitted to letter ballot of the committee for recommendation of advancement to standard.

B-8 on Electrodeposited Metallic Coatings:

A problem was advanced by the Industrial Fasteners Institute in regard to meeting dimension tolerances for threaded fasteners plated in accordance with A.S.T.M. Specifications for Electrodeposited Coatings of Zinc on Steel (A 164), Cadmium on Steel (A 165), and Nickel and Chromium on Steel (A 166). The Institute pointed out that these specifications are particularly difficult to apply to fasteners having complementary threads. It was decided

that consideration should be given to amending these specifications by means of a footnote to the effect that these particular specifications do not apply to fasteners having complementary threads. Committee B-8 is reviewing with the Society's Committee A-5 on Corrosion of Iron and Steel the development of new specifications for fasteners.

In the Specifications for Electrodeposited Coatings of Nickel and Chromium on Copper and Copper-Base Alloys (B 141), and Nickel and Chromium on Zinc and Zinc-Base Alloys (B 142), it was suggested that the present footnote *b* under Section 3 be amended to the effect that where minimum thicknesses cannot be obtained without exceeding the maximum suggested coating, an agreement should be reached between the producer and consumer as to the thicknesses to be specified. It was agreed, subject to letter ballot, that Specifications A 166, B 142, and B 200 for Electrodeposited Coatings of Lead on Steel be continued as tentative.

Subcommittee IV on Electroplating Practice has completed, or will have completed in the near future, recommended practices for plating on zinc-base die castings, copper and copper alloys, stainless steel, aluminum, and plastics. These recommended practices will be submitted to letter ballot as soon as they are ready. The subcommittee is also contemplating work on recommended practices for plating on tin, lead, and their alloys, and for plating on cast and malleable irons.

Subcommittee V on Supplementary Treatments for Metallic Coatings is developing an extensive program for testing supplementary treatments with and without organic coatings.

Considerable discussion was given to the establishment of a Subcommittee on Plating Solution Analysis. A special group will consider the advisability of establishing such a subcommittee and suggest what its scope might be.

The next meeting of Committee B-8 will be at the time of the Electrochemical Society meeting in Buffalo in the fall.

Committee C-1 on Cement:

At a well-attended meeting the various subcommittees of Committee C-1 reported on their respective activities. Resulting from that work, certain minor revisions were approved, for presentation to the Society, to clarify and improve details of some of the standard specifications and test methods relating to hydraulic cements.

Particularly interesting were the progress reports of current investigations in the subcommittees, and the discussions of the more important questions prompted by those reports.

Committee C-7 on Lime:

Among the items of interest presented in the subcommittee reports was a recommendation for a revision of the Standard Specifications for Hydraulic Hydrated Lime for Structural Purposes (C 141) which will classify this lime into two types with different limits for the chemical composition, time of set, strength, and soundness requirements. This was accepted for letter ballot of the committee. A definition of agricultural liming materials which has already been to letter ballot of the committee is being referred back to the Subcommittee on Definitions for further editorial revision but with authority to resubmit to committee letter ballot. In connection with agricultural liming materials, decision was reached to canvass all committee members on the need for specifications on such materials. The committee will meet during the 1950 Annual Meeting in Atlantic City.

C-8 on Refractories:

The present officers of Committee C-8 were nominated for re-election for the ensuing term. New chairmen of subcommittees were announced with J. J. Hazel assuming the chairmanship of Subcommittee IX on Classification, and R. A. Hindel taking over the chairmanship of Subcommittee XIII on Foreign Tests and Specifications.

General activity in all sections of Subcommittee III on Tests was reported. Included in this activity are cooperative tests on Pyrometric Cone Equivalent (P.C.E.) with an attempt to find the type of furnace most suitable for P.C.E. tests; several revisions in the procedure on analysis are ready for letter ballot; preliminary drafts of test methods covering consistency and other properties have been prepared and a new procedure has been developed for determining carbon monoxide disintegration. It is expected that this new method will be published as information only in order to secure additional comments. Two new definitions covering carbon refractories and carbon ceramic refractories, respectively, were accepted for letter ballot. A special group was appointed to clarify some confusion which exists as to what constitutes definitions, specifications, and classifications. There is still much preliminary work to be done in the field of special refractories in classifying the various oxides and minerals on the basis of being developed into commercial refractories.

The two newest fields entered by the committee, namely, that of carbon refractories and semisilica brick, show progress, including that made in cooperative tests being run on carbon refractories manufactured in the United States. It is expected that carbon refractories made in Great Britain will be tested for comparison with the American product.

The next meeting of the committee will be at Penn State College on September 14.

C-9 on Concrete and Concrete Aggregates:

In the research subcommittees consideration is being given to new approaches in measuring alkali reactivity of aggregates in concrete; the size and pore spaces in concrete aggregates and their relation to durability are under study, and the development of dynamic testing methods for measuring quality of concrete, particularly for field use, is under way. This last activity includes the use of the sonoscope method. The compiling of descriptions of the various rock types is contemplated.

Various projects and actions were reported from the specifications and test methods subcommittees. A change was recommended in the Standard Method of Sampling Fresh Concrete (C 172) to reconcile the procedures on flow and slump. It was proposed to consolidate all air-entraining test methods under one designation. What might be considered a revolutionary move was the decision to include limits in the Standard Specifications for Concrete Aggregates (C 33) for flat and elongated pieces. The conditioning temperature, as well as the mixing water and storage tank temperature, in the Standard Method of Test for Measuring Mortar-Making Properties of Fine Aggregate (C 87) was recommended for change to conform to the standard approved temperature of 23 ± 1.7 C. The title and scope of the A.S.T.M. Standard C 156 was approved for change to read "Method of Test for Water Retention Efficiency of Liquid Membrane-Forming Curing Compounds." It is expected that this limitation of scope will lead to extensive revisions. A third draft of a method of testing air-entraining admixtures was reviewed.

A statistical study of field determinations on ready-mixed concrete is being made for arriving at a better basis of evaluating the requirements of the Specifications C 94. The procedures for analyzing hardened concrete are under study for revision, and a different approach to the procedure is expected.

The committee will hold its next meeting during the Annual Meeting.

C-16 on Thermal Insulating Materials:

Leading off with meetings of the Planning and Executive Subcommittees,

(*continued on page 25*)

Wide Range of Testing and Scientific Equipment in Apparatus Display at Annual Meeting

Leading Companies Will Feature Many New Developments

NOT only will there be a varied range of testing equipment and laboratory supplies displayed during the Ninth Apparatus Exhibit in Atlantic City, the week of June 26, but many new developments will be featured. Thus, the Exhibit will provide members and the large number of visitors expected an unusual opportunity of learning the progress made in the instruments industry. Everyone interested is cordially invited to attend the Exhibit. All members and committee members will be admitted, and visitors by registering at the Exhibit entrance also can inspect the displays.

Hotel Rooms for Annual Meeting—Important!

It is physically impossible for Chalfonte-Haddon Hall or any other hotel in the country to fill every request from our members for a single room. Many of the members are quite anxious to stay at Chalfonte-Haddon Hall and to aid in providing accommodations at this hotel for as many members as possible it will be essential that members share twin-bedded rooms. The hotel return form *which will be mailed to all members and committee members early in April* will give information on all hotel facilities. A number of the other comparable Atlantic City hotels are cooperating in allocating rooms for the meeting.

In addition to leading manufacturers of testing machines of all kinds, there will be other groups concerned with laboratory supplies, glassware, metalware, electrical measuring devices, and a wide range of instruments used in evaluating the properties of materials. While much of the equipment shown will tie in with A.S.T.M. specifications and tests, most of the companies will have new products and instruments that are coming into use and where A.S.T.M. has not yet developed any procedures or standards.

A list of the exhibitors who have thus far applied for space is as follows:

American Instrument Co.
American Machine and Metals, Inc.
H. Reeve Angel & Co., Inc.
Atlas Electric Devices Co.
Baird Associates, Inc.
The Baldwin Locomotive Works
Bethlehem Apparatus Co.
Brabender Corporation
Brookfield Engineering Labs., Inc.
The Brush Development Co.
Buehler Ltd.
Burrell Corporation
Central Scientific Co.
Consolidated Engineering Corp.
Corning Glass Works
Custom Scientific Instruments, Inc.
J. W. Dice Co.
Eastman Kodak Co.
Henry A. Gardner Lab., Inc.
General Radio Co.
Hanovia Chemical & Mfg. Co.
Instron Engineering Corp.
Jarrell-Ash Co.
Leeds & Northrup Co.
Magnaflux Corp.
National Forge & Ordnance Co.
Tinius Olsen Testing Machine Co.
Radium Chemical Co.
Rubicon Co.
Scott Testers, Inc.
Sperry Products, Inc.
Steel City Testing Machines, Inc.
Superior Electric Co.
C. J. Tagliabue Corp. (N. J.)
Arthur H. Thomas Co.
Thwing-Albert Instrument Co.
Will Corporation
Wilson Mechanical Instrument Co.
Young Testing Machine Co.

The advance information received from these exhibitors indicates that the following types of equipment and instruments will be shown:

Autotransformers
Calorimeters
Colorimeters
Centrifuges
Chemical Glassware
Compression Testing Machines
Cyclographs
Electronic Devices
Filter Papers and Materials
Furnaces
Gas Analyzers
Hardness Testers
Hydraulic Testing Machines
Laboratory Mixers
Mercury Arc Lamps
Mercury Filters
Mercury Oxifiers
Metallographic Equipment
Non-Destructive Testers
Oscillographs
Paper Testing Equipment
Polariscopes
Potentiometers
Proving Rings
Recording and Control Instruments
Reflectoscopes
Rubber and Textile Testers
Shakers
Spectrographs
Strain Analyzers
Strain Gages
Stroboscopes
Surface Analyzers
Tensile Testers
Thermometers
Viscometers
Wear Testers
Weather Testers
X-ray Equipment

In the May ASTM BULLETIN there will be short descriptions of each booth display.

1950 Marburg Lecture—Brode on Spectroscopy

DR. WALLACE R. BRODE, National Bureau of Standards, has been selected by A.S.T.M. as a man eminently qualified to present this year's Marburg Lecture at the Annual Meeting.

Topic.—With a general review of the history of the science included, from the viewpoint of the development of standard methods and analytical controls, Dr. Brode will outline Chemical Spectroscopy. He will discuss the development and use of spectroscopic methods in analytical control. The use of both emission spectra and absorption spectra procedures will be outlined by Dr. Brode, and the method limitations will be indicated. The application to specific problems of these methods will be illustrated.

In colorimetry and color description, the application of these methods will be considered as well as the use of spectrophotometer procedures in the infrared and ultraviolet regions of the spectrum.

Part of the lecture will be devoted

Wallace R. Brode, 1950 Marburg Lecturer

Chase News Photo, Washington, D.C.

to the field of Emission Spectroscopy, including the development of rapid analysis procedures and the recent advance in photoelectric recording instruments.

About the Lecturer.—Dr. Wallace R. Brode was born in Walla Walla, Wash. Graduating from Whitman College in 1921 he received his M.S. and Ph.D. degrees in 1922 and 1925 from the University of Illinois. Dr. Brode was a chemist at the National Bureau of Standards from 1923 to 1926. In 1926 he received a Guggenheim Foundation Fellowship for study at Leipzig and Zurich, and this was renewed for a second year in 1927 for study at Liverpool, England.

From 1928 to 1948 Dr. Brode served as Professor of Chemistry at the Ohio State University and resigned from the University in 1948 to accept his present position as Associate Director of the National Bureau of Standards. While at the Ohio State University, Dr. Brode established a laboratory and curriculum in Chemical Spectroscopy. He published a general textbook in this field of "Chemical Spectroscopy"; he co-authored many other texts and reference works in Spectroscopy and Organic Chemistry. Together with his independent researches he has published nearly 100 technical articles in American and Foreign scientific journals.

Dr. Brode served in several capacities during the recent World War with O.S.R.D., including direction of an N.D.R.C. Project at the Ohio State University and later as head of the Paris Office of O.S.R.D. from September, 1944, until July, 1945. He also served as Head of the Science Department of the Naval Ordnance Test Station at Inyokern from 1945 until 1947 and is now a member of their Advisory Board.

Dr. Brode has served on Committee E-2 of A.S.T.M. for a number of years and is now actively engaged in the organization of Committee E-13, on Absorption Spectra Analysis. An A.S.T.M. representative on the Intersociety Color Council, he is also a member of the American Chemical Society, Optical Society of America, American Association for Advancement of Science, and is a present member of the Physical Division of the National Research Council. He is a member of the Board of Directors of the Optical Society of America and of the Board of Governors of the American Institute of Physics.

He has just been elected Editor of the *Journal* of the Optical Society of America on whose Board of Editors he has served as an Associate Editor for a number of years.

Dr. Brode is at present one of the two Associate Directors of the National Bureau of Standards. He is primarily responsible for the coordination of the chemical interests in the Bureau including the Divisions of Chemistry, Metallurgy, Organic and Fibrous Materials and Mineral Products, as well as Bureau-wide responsibilities in the fields of Education, Facilities, and Foreign Relations.

1950 A.S.T.M. Photographic Exhibit

Entries Solicited

THE Seventh Photographic Exhibit and Competition, to be held in conjunction with the Fifty-third A.S.T.M. Annual Meeting and Ninth Exhibit of Testing Apparatus and Related Equipment, will really be in three parts: a General Section devoted to the subject, Materials Testing and Research; and two other divisions, one dealing with Photomicrography, under the sponsorship of Committee E-4, and the other on Radiography sponsored by Committee E-7 on Non-Destructive Testing. Each of these technical groups has arranged interesting displays in previous years and this year they should be of even more interest. The Photographic Exhibit will be arranged in part of the Gallery off the Garden Room in Haddon Hall, just outside of the Apparatus Exhibit, and the prints and entries can be viewed during the Exhibit hours.

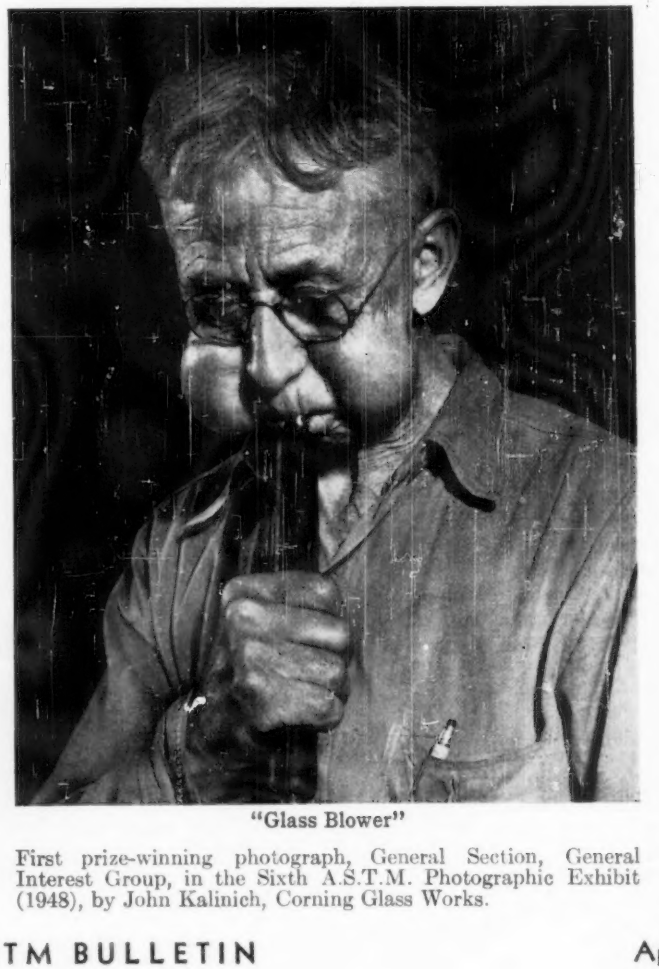
The Photographic Exhibit, sponsored by the Philadelphia District is being arranged by a committee consisting of the following:

L. Drew Betz, *Chairman*, W. H. and L. D. Betz
D. I. Finch, Leeds & Northrup Co.
C. B. Jenni, General Steel Casting Co.
Myron Longenberger, Rohm & Haas Co.
R. R. Moore, U. S. Naval Aircraft Factory
S. Byron Morehouse, Leeds & Northrup Co.
John P. Mudd, The Midvale Co.
E. B. Patterson, Arthur H. Thomas Co.

Pacific Area Papers on Cast Iron and Soils

SOCIETY members will be interested to know that the following four papers, which were presented at the First Pacific Area Meeting of A.S.T.M. last fall, are to appear in *Foundry* magazine.

"Mechanical Testing and Properties of



"Glass Blower"

First prize-winning photograph, General Section, General Interest Group, in the Sixth A.S.T.M. Photographic Exhibit (1948), by John Kalinich, Corning Glass Works.

Gray Cast Iron," C. K. Donoho, American Cast Iron Pipe Co., Birmingham, Ala.

"Development, Significance and Uses of Specifications for Cast Iron," H. Bornstein, Deere and Co., Moline, Ill.

"Automotive Cast Irons, Including Brake Drums," R. G. McElwee, Vanadium Corporation of America, Detroit, Mich.

"Application and Uses of Gray Iron Castings, Including Significance of Various Properties of Gray Cast Iron," C. O. Burgess, Gray Iron Founders' Society, Inc., Cleveland, Ohio.

Mr. Bornstein's paper will probably be the first to appear—in the April or May issue.

The paper, "Studies of Construction Problems and Methods of Compacting Different Type Soils to Optimum Density," by A. W. Root and T. E. Stanton, both of California Division of Highways, is also scheduled to appear soon in the *Western Construction News*.

Standards Committee Approvals During March

DURING the past few weeks, the Administrative Committee on Standards has approved several new tentative specifications, tentative revisions of existing test methods, and new tentative methods of test. The specific approvals by the Administrative Committee are listed in the accompanying table. Some notes on the recommendations made to the Administrative Committee on Standards are included below.

To evolve a more satisfactory method of handling the air entraining additions problem, particularly to remove Committee C-1 from a position as judge—and sometimes as a testing agency—in preparing any new materials, Committee C-1 on Cement proposed the tentative Specifications for Air Entraining Additions for Use in the Manufacture of Air Entraining Portland Cement (C 226 – 50 T). To provide conditions governing a method of retest, Committee C-1 also submitted a proposed tentative revision of Standard Methods of Test for Heat of Hydration of Portland Cement (C 186 – 47). A proposed tentative Method of Test for Potential Alkali Reactivity of Cement-Aggregate Combinations was submitted by this committee based on experience gained with the reactivity of certain cement-aggregate combinations. This test will be made by measuring expansion developed by the combinations in mortar bars during storage under prescribed conditions.

Because an adequate standard was lacking, Committee C-14 on Glass and Glass Products recommended that proposed Methods of Sampling and Testing Structural Non-Load-Bearing Cellular Glass Blocks (C 240 – 50 T) be approved as a tentative standard. The proposal had been carefully considered by the main committee and had undergone two revisions in the subcommittee before it was submitted to the Administrative Committee on Standards.

Committee D-9 on Electrical Insulating Materials recommended a new Tentative Specifications for Absorbent Laminating Paper for Electrical Use. It is intended only for the use of laminators and paper manufacturers and not for incorporation in purchase specifications for laminates. The proposal was made since there is a real need for such specifications expressed by a number of manufacturers in this country who produce phenol-formaldehyde or melamine-formaldehyde impregnated cellulose paper laminates. Since a considerable portion of the phenolic laminate is used for electrical insulating purposes, the requirements for laminates have been standardized for many years. However, there has been no commonly accepted specifications governing the requisite characteristics of this paper—over 35,000 tons were produced in 1948—used in the manufacture of phenolic laminate. The variety of dissimilar tests for paper quality which have been specified by various laminators created an onerous problem for the paper mills, made the furnishing to laminators unpopular, and resulted in supply shortages during the post war period. By active cooperation of paper makers and users on Committee D-9, assisted by the National Bureau of Standards and consulting members such as the Institute of Paper Chemistry, development of new tests where necessary and round-robin tests on various suppliers' paper in different laboratories, the specifications were evolved over the past three years. They incorporate essential properties and test methods for four types of absorbent papers suitable for the manufacturer of electrical laminates.

Committee D-9 also recommended as tentative, Methods of Testing Natural Mica for Power Factor and Dielectric Constant (D 1082 – 49 T). In the past few years, this test method had been included in the Standard Methods of Testing, Grading and Classifying Natural Mica (D 351 – 46). That part of Methods D 351 referring to specifications for grading and classifying natural mica has been revised and the test procedure for dielectric loss characteristics now will be a separate tentative—apart from grading and classifying by visual quality. The Standard Methods of Testing, Grading, and Classifying Natural Mica (D 351 – 49 T) has been revised and reverted to tentative. The revision concerns the addition and modifications of the test methods that control visual quality, usability, area, thickness, hardness, stiffness, optical angle, and weight

Actions of A.S.T.M. Administrative Committee on Standards March 1, 1950

New Tentatives

Specifications for:

Air-Entraining Additions for Use in the Manufacture of Air-Entraining Portland Cement (C 226 – 50 T).

Absorbent Laminating Paper for Electrical Use (D 1080 – 49 T).

Methods of:

Test for Potential Alkali Reactivity of Cement-Aggregate Combinations (C 227 – 50 T).

Sampling and Testing Structural Non-Load-Bearing Cellular Glass Blocks (C 240 – 50 T).

Testing Natural Mica for Power Factor and Dielectric Constant (D 1082 – 49 T).

Testing Large Shipping Cases and Crates (D 1083 – 50 T).

Tentative Revision of Standards

Method of Test for:

Heat of Hydration of Portland Cement (C 186 – 49).

Revision of Standard and Reversion to Tentative

Methods of:

Testing, Grading, and Classifying Natural Mica (D 351 – 46) including the change in title to read as follows: Tentative Specifications for Natural Muscovite Mica Based on Visual Quality (D 351 – 49 T).

Revision of Tentative

Methods of:

Testing Askarels (D 901 – 46 T).

loss or heating for control purposes of commercially available natural muscovite brick and film mica—independent of the basic color of the mica or its source.

Along with a precautionary statement concerning the use of cells containing phenolic resin-bonded insulation, a revision of Tentative Methods of Testing Askarels (D 901 – 46 T) designates A.S.T.M. Standard (D 924 – 47 T) as the method for determining power factor and dielectric constant of askarels. The precautionary statement was added since phenolic resin has a deleterious effect on askarels, causing erroneous (high) power factor readings.

Committee D-10 on Shipping Containers submitted a new tentative on Method of Testing Large Shipping Cases and Crates (D 1083 – 50 T). This method provides a means for determining the resistance of large shipping cases and crates to handling conditions.

NEW PUBLICATIONS

Important Society Books Published in Recent Weeks

DURING the past month several publications have taken their place on the shelves of A.S.T.M. In spite of the press of many activities which have required much time and effort (such as A.S.T.M. Committee Week, numerous separate committee meetings, preparation for the Annual Meeting), it has been possible to forge ahead in the revising of old documents and the editing of new ones—so that all can be fed to the typesetters and finally the presses.

One of these recent additions is the Symposium on the Testing of Cast Iron with SR-4 Type of Gage.

The Steel Piping Compilation and the one on Adhesives bring the standards relating to these particular fields together in handy form and should find extensive use. Parts 1 and 4 of the 1949 Book of A.S.T.M. Standards have been "lined up" beside Parts 2 and 5. The last two parts, 3 and 6, are nearing completion.

The strength of wrought steels at elevated temperatures is also described in a new report reviewed below.

A.S.T.M. Specifications for Steel Piping Materials

THE seventh edition of this compilation, issued for the first time in this form in 1942, will provide all those concerned with the production and use of steel piping materials with a handy and up-to-date compilation of a great majority of the A.S.T.M. specifications of concern in the field of steel piping. Grain size charts are also included.

Most of the specifications have been developed through the work of Committee A-1 on Steel, its Subcommittee IX on Pipe and Tubing and XXII on Materials for High-Temperature Service—piping, castings, forgings, bolts and nuts, and welding fittings. The proposed American Standard for Wrought Steel and Wrought Iron Pipe (A.S.A. No.: B36.10-1950) and the American Standard for Stainless Steel Pipe (A.S.A. No.: B36.19-1949) are reprinted in the compilation through the courtesy of The American Society of Mechanical Engineers.

These specifications are in widespread use, and it is hoped the compilation will be of distinct service to the engineer, purchasing agent, and other technologists concerned with power plants and similar industrial installations, refineries, distribution of water, gas, oil, and the like, and to individuals in every industry where these materials are so important.

The 328-page compilation is $3 to nonmembers and $2.25 to A.S.T.M. members.

Testing Cast Iron with SR-4 Type Gage

THE papers and discussions comprising the symposium on the Testing of Cast Iron with the SR-4 Type of Gage has recently been published by the Society.

Fifteen papers describe residual stresses and their analysis in cylinder blocks, engine frames, cylinders, cast-iron beams, valve bodies and parts, deaerating trays, punch-press frames, tractor castings, textile machinery parts, and railroad service cast irons.

The significance of this symposium is evidenced by the introductory remarks of J. S. Vanick, Chairman of Committee A-3 on Cast Iron:

"Commercial gray iron castings are often designed in complex shapes which may integrate a number of simple geometrical figures into a final form. Plotting the flow of stress in a complex casting under load may become a jigsaw puzzle. One of the most aggravating cases occurs when a surface that should develop a tensional stress actually registers a compressional stress. Stress patterns that are further complicated by the cross-movements of static loads, dynamic loads, and thermal loads, combine to confuse the designer. In early designs, it is common to plan, build, test, and load the job to destruction, then redesign or "beef up" the weakened zones, and finally proceed with casting production.

"Because cast iron will break with a nonductile fracture under simple tensile stress, its application has occasionally been avoided in favor of more ductile material which will deform and thus sound a warning, or it will malfunction in a dynamic loading system and thereby give notice of impending failure. Nonductile fractures are known to develop in ductile materials like steel, as in the case of the fatigue failure. Methods for exploring the stress distribution in castings have been provided by various means and specifically in the strain-resistance wire gage system.

"Where equipment for stress-strain analysis is available, it has invariably been found possible to significantly improve the physical configuration of a given casting so as to meet more efficiently the stresses involved and also to materially decrease the weight of the casting, with an advantageous effect on economy. Equally important is the application of stress-strain measurements for the purpose of increasing confidence of the designer in gray iron as an engineering material."

Part 1, 1949 Book of A.S.T.M. Standards—in the Mails

AS THIS issue of the ASTM BULLETIN goes to press, the users of our Standards on Ferrous Metals will be glad to know that Part 1 of the new Book of A.S.T.M. Standards is now available.

Part 3 on Cement, Refractories, Glass, Thermal Insulation, Concrete, Road Materials, Waterproofing, and Soils is now in the printer's hands and should be available within a few days.

This symposium was sponsored by Committee A-3 at the 1949 Annual Meeting.

Profusely illustrated, the 92-page symposium contains over 60 data curves and tables and numerous photographs. The paper-bound booklet is priced at $1.65 for nonmembers and $1.25 for members.

A.S.T.M. Standards on Adhesives

THIS Second Edition of the compilation of Standards on Adhesives, now available, is sponsored by A.S.T.M. Committee D-14 on Adhesives, and brings together all the latest A.S.T.M. methods of test pertaining to the adhesives field. There are also included three methods of testing rubber adhesives prepared by Committee D-11 on Rubber and Rubber-Like Materials.

The scope of Committee D-14 covers the formulation of specifications, methods of test, and definitions of terms pertaining to adhesives, including animal, vegetable, mineral, and synthetic types. The membership of the committee and its eight active subcommittees is composed of representatives of producing and consuming interests in the industry.

The test methods included cover Viscosity and Total Solids Content of Rubber Cements, Lattices of Natural and Synthetic Rubbers, Resistance of Adhesive Bonds to Chemical Reagents, Tensile Properties of Adhesives, Applied Weight Per Unit Area of Dried Adhesive Solids, Applied Weight Per Unit Area of Liquid Adhesive, Peel or Stripping Strength of Adhesives, Recommended Practice for Determining the Effect of Artificial (Carbon Arc Type) and Natural Light on the Permanence of Adhesives, Strength Properties of Adhesives in Shear by Compression Loading, Strength Properties of Adhesives in Plywood Type Construction in Shear by Tension Loading, Definitions of Terms Relating to Adhesives, Impact Strength of Adhesives, Strength Properties of Metal-to-Metal Adhesives in Shear by Tension Loading, and Cleavage Strength of Metal-to-Metal Adhesives.

This publication should be useful to industry generally and particularly to the purchasers and producers of adhesives.

It contains 66 pages, is 6 by 9 in., and is bound in heavy paper cover. Prices are as follows: 1 to 9 copies, $1.25; 10 to 49 copies, 95 cents. To A.S.T.M. members, 95 and 75 cents, respectively.

New Publication on Strength of Wrought Steels at Elevated Temperatures

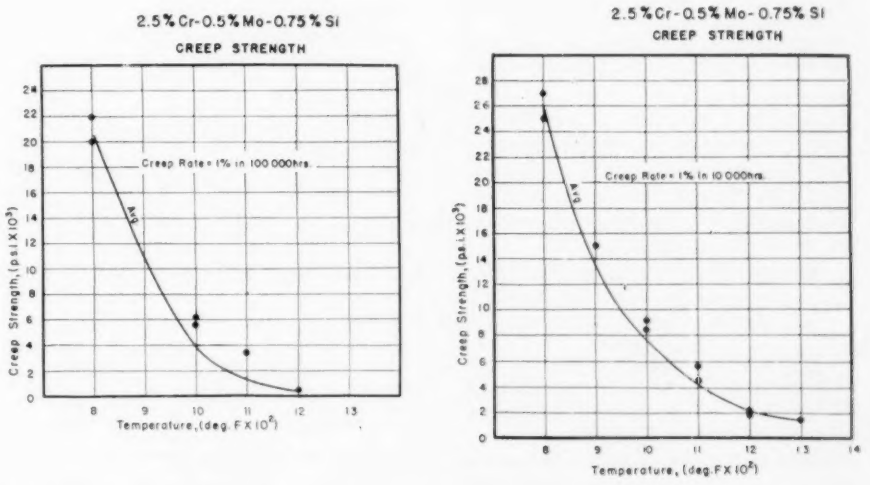
Data Should Be of Widespread Interest to All Metallurgists and Those Concerned with Using Steels

AN important new publication is virtually off press entitled "The Strength of Wrought Steels at Elevated Temperatures." Issued under the auspices of the A.S.T.M.-A.S.M.E. Joint Committee on Effect of Temperature on the Properties of Metals, the report, comprising some 116 pages ($8\frac{1}{2}$ by 11-in. page size), was prepared by R. F. Miller and J. J. Heger, Research and Technology Division, Carnegie-Illinois Steel Corp. With a great amount of up-to-date data on various properties of wrought steels, both carbon and alloy, at elevated temperatures, this book will go a long way toward meeting urgent needs on the part of both the producer and consumer of materials. Designers of power equipment, chemical apparatus, and machinery, operating at elevated temperatures, should find the book particularly useful.

Basically, the extensive tabular and graphical data cover the tensile, creep, and rupture properties of standard commercial grades of both carbon and alloy steels. The report is in two sections, the first relating to the plain carbon and also alloy steels with molybdenum and up to 3 per cent chromium. The second section covers materials with more than 5 per cent chromium.

The Joint Committee has had numerous urgent requests from various code-writing bodies and other sources to compile up-to-date data on the high-temperature properties of various metals. Its volume on "Creep Data" issued in 1938 is out of print, and of course much of the information is obsolete, and although another survey is currently to be instituted under the direction of the Data and Publications Panel of the Joint Committee, which group is headed by Dr. Miller, it will be many months before any data from the survey are issued. Extensive questionnaires are necessary to elicit the data and to compile all available data which might involve two or three years work. Meanwhile it was learned that Miller and Heger had been compiling and keeping up to date rather extensive data, not only from their own company records but from many other sources, and when they offered this to the Joint Committee for publication, the Committee felt it would be a real service to issue the material, and the offer was promptly accepted.

While the book includes considerable tabular material with rather complete references as to sources, what makes it of particular value are the extensive curves and charts. The applicable A.S.T.M. standards for the various steels are given for each steel. This information further enhances the value of the report. The publication represents a tremendous amount of work on the part of the authors and their associates. Copies of the book in a heavy paper cover, saddle-stitched, can be procured from A.S.T.M. Headquarters at $3 each, the price to members of A.S.T.M. being $2.25.


2.5% Cr-0.5% Mo-0.75% Si
CREEP STRENGTH
Creep Rate = 1% in 100 000 Hrs.
Creep Strength, (psi X 10³)
Temperature, (deg. F X 10²)
2.5% Cr-0.5% Mo-0.75% Si
CREEP STRENGTH
Creep Rate = 1% in 10 000 Hrs.
Creep Strength, (psi X 10³)
Temperature, (deg. F X 10²)

Sample twin curves from "the Strength of Wrought Steels at Elevated Temperatures" showing relation of creep strength and temperatures, for an alloy steel, at two creep rates. (Figures reduced about one half)

ASTM Bulletin

APRIL 1950

NO. 165

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

Nominations for Officers

THE Nominating Committee to select nominees for Society officers met in Philadelphia on April 14. The personnel of this group was listed in the October, 1949 BULLETIN. In accordance with the provisions of the By-laws of the Society the following nominations are announced:

For President (term 1 year):

L. J. Markwardt, Assistant Director, U. S. Forest Products Laboratory, Madison 5, Wis.

For Vice-President (term 2 years):

T. S. Fuller, Engineer in Charge of Works Laboratory, General Electric Co., Schenectady 5, N. Y.

For Board of Directors (term 3 years):

B. A. Anderton, Consultant, Research and Development Department, The Barrett Division, Allied Chemical and Dye Corp., Research Laboratory, Edgewater, N. J.

R. H. Brown, Sales Engineer, Parks-Cramer Co., Fitchburg, Mass.

D. K. Crampton, Director of Research, Chase Brass and Copper Co., Inc. Waterbury 2, Conn.

H. G. Miller, Mechanical Engineer, Chicago, Milwaukee, St. Paul & Pacific Railroad Co., Milwaukee 3, Wis.

J. R. Trimble, Assistant Manager, Department of Metallurgy, Inspection and Research, Tennessee Coal, Iron and Railroad Co., Birmingham 2, Ala.

Each of the above nominees has indicated in writing his acceptance of his nomination. The By-laws provide that "further nominations, signed by at least 25 members, may be submitted to the Executive Secretary in writing by May 25, and a nomination so made, if accepted by the member nominated, shall be placed on the official ballot" which "shall be issued to members between May 25 and June 1."

Use of the Headquarters Building for Meeting

COMMITTEES of the Society and of other technical and scientific organizations have a standing invitation to use the Headquarters Building for their meetings. The board room, which can accommodate as many as fifty (and can also be divided into two separate rooms) and the committee room, which can accommodate twenty, are used regularly for this purpose. The members' room is also available for small meetings.

During the past year these facilities were used for 76 various committee meetings and conferences. Members who have used them have frequently expressed their satisfaction that the Society has such a fine building of its own for its headquarters and for conducting the meetings so vital to its existence.

Revisions of Regulations Governing Technical Committees

SEVERAL revisions of the Regulations Governing Technical Committees have been approved since the appearance of the 1949 Year Book and they are accordingly recorded here for the information of the members in order that they may know that the revisions are now in effect.

The first one is a revision of the last paragraph of Section 2 (*g*) which has to do with numeric balance of committees dealing with commercial matters. Instead of requiring a substantial balance with respect to interest between the general classifications—producers, consumers, and general interest—the revised wording stipulates that a balance should be maintained between producers on the one hand and consumers and general interests jointly, on the other hand, and in this it reverts to the wording in effect prior to 1934. The revised wording reads as follows:

"On such committees either an equal numeric balance shall be maintained between the producers on the one hand and the consumers and general interests, jointly, on the other hand; or the consumers and general interests may be allowed to predominate in the absence of objection by a majority of the producers. Thus a substantial balance may be permitted to exist between the three general classifications of members on technical committees."

The second revision was suggested at the time the first revision was under consideration and relates to the voting requirement as set forth in Section 14. The revised wording is indicated below with the additional material italicized. It places a further limitation on the vote so that no recommendation will be approved that meets with the objection of more than one third of either the producers or non-producers.

"14. Procedure Governing Recommendations on Standards.—(*a*) Committee recommendations affecting standards shall normally be agreed upon at regularly called meetings. (For an alternate to this 'normal' procedure, see Paragraph (*b*).) An affirmative vote amounting to two

Schedule of A.S.T.M. Meetings

DATE	GROUP	PLACE
April 21	Western New York-Ontario District	St. Catharines, Canada
April 26	Committee C-14 on Glass and Glass Products	New York, N. Y.
April 27–28	Committee D-10 on Shipping Containers	Madison, Wis.
May 8–9	Board of Directors	(A.S.T.M. Headquarters)
June 26–30	53rd Annual Meeting and 9th Exhibit of Testing Apparatus and Equipment	Atlantic City, N. J.
October 8–11	Committee D-2 on Petroleum Products and Lubricants	Detroit, Mich.
October 18–20	Committee D-13 on Textile Materials	New York, N. Y.

thirds of those voting shall be required on all recommendations affecting standards, subject to confirmation by letter ballot of the entire committee on which an affirmative vote amounting to two thirds of *the combined number of consumers and general interests voting and two thirds of the producers* [those] voting shall also be required. The number of affirmative, negative, and 'not voting' ballots shall be included in the report of the committee to the Society. If the number of negative votes on the letter ballot exceeds 10 per cent of the sum of the affirmative and negative votes, the report to the Society shall also contain a classification of the total vote as to producers, consumers, and general interests (see Section 2 (*h*))."

The third revision consists of the insertion of provisions covering a procedure to be followed by those technical committees wishing to write standards on ultimate consumer goods. The technical committees themselves would not normally have the balance required under Section 2 (*g*), and the revision sets forth how an exception can be made in the case of work on ultimate consumer goods. This avoids the necessity of organizing a separate committee to handle such Standards and keeps this work completely under the aegis of the technical committee.

Insert at the end of Article I, Section 2 (*g*):

"An exception to this rule may be involved in certain actions connected with ultimate consumer goods[1] as set forth in Article III, Section 14 (*c*)."

Add the following to Article II, Section 9:

"(See also Article III, Section 14 (*c*).)"

Change Article III, Section 14 (*c*) to Section 14 (*d*) and insert the following new Section 14 (*c*):

"14 (*c*). In certain cases of actions involving ultimate consumer goods[1] it may not be feasible to establish in the appropriate existing technical committee the balance of interests concerning a particular item of consumer goods as prescribed in Article I, Section 2 (*g*). In such cases where recommendations regarding standards or recommended practices involve ultimate consumer goods,[1] the following special provisions shall apply. The technical committee may refer the matter with proper recommendations to a special subcommittee which shall consist of not fewer than nine members and to which shall be applied (rather than to the technical committee) the balance of interests as prescribed in Section 2 (*g*) including representation of the ultimate consumer. Recommended action by such subcommittee shall be by not less than two thirds affirmative vote by letter ballot. Such subcommittee recommendations shall be addressed to the technical committee and shall then be handled as usual under Sections 14 (*a*) or (*b*)."

Should Method of Acting Upon Committee Reports and Standards Be Changed?

THOSE who have attended the annual meeting sessions over a period of years are familiar with the method of presenting committee reports and the procedure followed by the Society in taking action upon committee recommendations. In line with the procedure set forth in the by-laws of the Society, committee recommendations are presented at the annual meeting and acted upon by the members of the Society present. It has been traditional to have committee reports and technical papers presented at the same session and for a number of years when there were not so many committees from which reports were to be received, this worked out very well and the sessions were of sufficient technical interest to justify a reasonable attendance. More recently, however, the number of committee reports requiring presentation and action increased to such an extent that it became increasingly difficult to schedule them at sessions interspersed with technical papers.

Following the experience of the abbreviated wartime annual meeting held in New York in 1945, devoted entirely to committee reports, several sessions were arranged at the Buffalo annual meeting in 1946 consisting entirely of committee reports with as many as fifteen reports presented at a single session. At this same meeting a number of symposiums were held, and segregating the committee reports in this way contributed to very interesting and well-attended symposium and technical paper sessions. There was, however, some criticism of the report sessions as being poorly attended and lacking in interest, and in response to requests of some committees later annual meetings reverted to the earlier type of scheduling, with committee reports and technical papers interspersed. Some of the sessions have not been too successful, particularly where committee reports are scheduled in sessions where there are no papers in the same technical fields.

Studied by Board:

With this background and experience in mind, the Board of Directors has given a great deal of consideration to this entire subject, realizing the necessity for the presentation of committee reports and action on the recommendations contained therein and at the same time providing sessions that will be of technical interest to our members. The entire procedure on the promulgation of standards as set forth in the by-laws is predicated on having this procedure democratic, not only in the consensus required in the sponsoring technical committee itself, but also in the manner in which the Society acts as a whole on standards. Recommendations covering publication as tentative *only* can, and are, submitted in large number to the Administrative Committee on Standards throughout the year, but this procedure is intended primarily as a means of expediting action on tentatives in the interim between annual meetings. *All* recommendations covering *adoption as standard* definitely require annual meeting action subsequently confirmed by letter ballot. It is desirable that the democratic aspect of the procedure be preserved, whereby any member of the Society has an opportunity to be heard and has a voice before the final adoption of a standards recommendation.

Review Panels Proposed:

The Board appointed a special study committee to bring in recommendations. This study committee has proposed what it terms a "review panel" procedure of review at the annual meeting *in lieu* of presentation before a regular annual meeting session. This proposal is set forth below as a suggested revision of the by-laws and has received favorable comment by a number of technical committee officers to whom it has been submitted. However, it has also been criticized on the score that it would not be as democratic a procedure as is new in effect, for while the members of the Society would have an opportunity to appear before the panel and present their views, they would not participate in the voting—except, of course, in the final letter ballot of the entire Society on adoption of standards. In other words, the action at the annual meeting on committee recommendations would be taken by the review panel, in a manner similar to present action on tentatives by the Administrative Committee on Standards.

[1] Ultimate Consumer Goods have been defined by the Administrative Committee on Ultimate Consumer Goods as materials or products which in the "as is" condition are intended for sale to an individual purchaser for his personal property or use, and not for fabrication for resale.

The Board of Directors will welcome comments by the membership at large as to the suitability and adequacy of the proposed panel review procedure. The procedure followed by the Society in promulgation of standards is an all-important one and it is hoped that the members will assist the Board by offering comments and suggestions.

Suggested Revisions in Article VII of By-Laws

(New wording in italics. Words in brackets to be deleted)

ARTICLE VII. PROCEDURE GOVERNING THE ADOPTION OF STANDARDS

Sec. 1.—(No change)

Sec. 2.—(No change)

Sec. 3.—(No change)

Sec. 4.—The procedure governing the promulgation of standards shall be as follows:

(*a*) Acceptance of tentative revisions of standards, tentatives, and revisions of tentatives, and withdrawal of standards, tentatives, and tentative revisions of standards, shall be either by action *of Review Panels at the Annual Meeting* of the Society as provided in Paragraphs (*b*), (*c*), [and] (*d*) *and* (*e*) or of the Administrative Committee on Standards as provided in Paragraph (*f*). Adoption of standards and of revisions of standards, however, shall only be by action of Review Panels [of the Society in] *at the* annual meeting *as provided in Paragraphs* (*b*), (*c*), *and* (*d*), followed by letter ballot of the Society.

(*b*) *At the annual meeting, Review Panels appointed by the Board of Directors shall act for the Society on all committee recommendations regarding standards. Such action shall be taken in open meetings scheduled and held during the annual meeting sessions and calculated to provide opportunity for discussion by any member of the Society. The number of Review Panels to be provided, their respective fields of coverage, their composition, their relationship to the Administrative Committee on Standards, and their rules of procedure shall be determined from time to time by the Board of Directors.*

[(*b*)] (*c*) An affirmative vote, [amounting to two thirds of those voting at the annual meeting], *with not more than one member of the Review Panel voting negatively*, shall be required on all committee recommendations, except those involving immediate adoption of standards and immediate revision of standards. (For procedure on these exceptions see Paragraph [(*c*)] (*d*).) These committee recommendations may be amended by an affirmative vote *with not more than one member of the Review Panel voting negatively, and* [amounting to two thirds of those voting,] subject to approval of the revised recommendation by letter ballot of the committee; however, if the revised recommendation is rejected by the committee, the original committee recommendation shall be referred to the committee for study and *subsequent* report [at the next annual meeting].

[(*c*)] (*d*) If, *at an annual meeting*, immediate adoption as standard is recommended, either of a proposed new standard or of a revision of an existing standard without the usual preliminary publication as tentative, [a nine-tenths rather than a two-thirds affirmative vote] *a unanimous vote of the Review Panel acting on the recommendation shall be required.* [In this case no amendment on the floor of the meeting shall be permitted, except with unanimous consent.]

[(*d*)] (*e*) [Action of the Society] *Acceptance of recommendations by a Review Panel* at the annual meeting on the adoption or revision of standards is subject to approval by letter ballot of the Society, an affirmative vote amounting to two thirds of those voting being required, except that in the case of the immediate adoption of a standard or of the immediate revision of a standard without the usual publication as tentative, a nine-tenths rather than two-thirds affirmative vote shall be required.

[(*e*)] (*f*) Committee recommendations on acceptance of tentative revisions of standards, tentatives and revisions of tentatives, and on withdrawal of standards, tentatives, and tentative revisions of standards, may also be presented between annual meetings to the Administrative Committee on Standards for action on behalf of the Society. The Administrative Committee on Standards shall determine whether the requirements of the Society relating to committee procedure have been met and whether the committee has reached a satisfactory consensus. During consideration of the recommendation of a technical committee, representatives of the committee may be present and participate in the discussion. If the Administrative Committee on Standards takes favorable action upon the recommendation, the technical committee shall report the action in its next annual report.

Typographical Errors in Part 2, Non-Ferrous Metals, 1949 Book of Standards

It has been brought to the attention of Headquarters that during the printing of Part 2 of the 1949 Book of Standards (p. 38), several values have been dropped in Table III on Tensile Requirements of the Standard Specifications for Copper-Base Alloys in Ingot Form for Sand Castings (B 30–49). These values are as follows:

Alloy	Elongation in 2 in., min., per cent
2A	22
2B	18

Also in some copies of the book the type for "Alloy 4A" became defective and appeared as "Alloy 4."

Corrected pages 37 and 38 will be available from A.S.T.M. Headquarters upon request.

Also in Plate I (opposite p. 1088) of the Tentative Methods for Estimating the Average Grain Size of Wrought Copper and Copper-Base Alloys (E 79–49 T), the second micrograph in the top row, change "0.0025 mm. average grain diameter" to read "0.025 mm. average grain diameter."

In Standard Specifications B 229 for Concentric-Lay-Stranded Copper and Copper Covered Steel Composite Conductors on p. 444 the upper limit of lay for types A, C, and D conductors in Section 4(a) should read "20" times the outside diameter of the completed conductors and not "18" as it now appears.

Textile Institute Year Book

THE Year Book of the Textile Institute, Manchester, England, the second issue of which (for 1949–1950) is now available, again provides a comprehenisve guide to the wide range of activities of the Institute.

The amount of data given is extended considerably in the present issue, which contains 258 pages and which will be found to be of considerable value by all textile technologists and students.

Other information includes lists of literature for students and of general textile literature currently or shortly to be available, and the addresses of more than 200 organizations connected with textiles.

Standardization work of the Institute in textiles is fully covered. A comprehensive list of textile terms and definitions is included, together with data and tables connected with yarn count systems, as well as standards relating to the determination of yarn count, the designation and determination of twist in yarns, moisture in relation to textile materials, shrinkage on laundering, Bundesmann type water-repellency testing apparatus, method of testing water-repellency, measurement of cloth thickness, and determination of breaking load.

The case for a universal system of yarn counts is discussed, and comparative tables of yarn equivalents are given. Other technical data included deal with the relation between pH, acidity, and alkalinity and with the hardness of water. Physical constants are also given.

The members' list includes the names and addresses of 4725 members, an increase of almost 1000 members since the 1948–1949 list was issued.

Copies of the Year Book are available to nonmembers from the Textile Institute, 16, St. Mary's Parsonage of the Institute, Manchester 3.

DISTRICT ACTIVITIES

FROM the news accounts given below, it will be noted that several meetings have been held under the auspices of various A.S.T.M. Districts. The attendance at each of these has been very good, and in each case the speakers covered their subjects in an authoritative and interesting manner.

Forthcoming Meetings:

In addition to the meeting in St. Catharines, Ontario, on April 21 under the auspices of the Western New York-Ontario District (see below), the New York District is scheduling what promises to be an interesting get-together on Thursday, May 11, in the Port Authority Building, at 15th St. and Eighth Ave. Some additional details are noted below.

On the administrative side, each of the Districts has had Nominating Committees appointed, and these groups have been selecting nominees for councilors and for District officers for the ensuing term of two years. This year the terms of all officers, Chairman, Vice-Chairman, and Secretary expire, and those of approximately half the councilors.

A letter ballot for each of the respective Districts will be sent to the A.S.T.M. members and committee members in the areas covered. This material goes in the mails before May 25.

New York, May 11:

At the New York District meeting on May 11 at 7:30 p.m. sharp in the Port Authority Building, 15th St. and Eighth Ave., there will be discussions by two prominent engineers, covering the Brooklyn-Battery Tunnel and the Port Authority Bus Terminal now under construction. Both of these projects are of vital interest and concern to many in the New York area. In addition to the talks, there is to be a short motion picture showing some of the construction work carried out under Port Authority auspices. Speakers will be Mr. Ralph Smillie, Chief Engineer of the Triborough Bridge and Tunnel Authority, who will cover the Brooklyn-Battery Tunnel, and Mr. John M. Kyle, Chief Engineer of the Port of New York Authority who will discuss the Bus Terminal.

Direct mail notices are going to all members and committee members in the New York District and any A.S.T.M. members in the city at the time are cordially invited to attend.

New England, April 10, Energy:

"Competitive Sources of Energy," by Warren K. Lewis, Professor of Chemical Engineering (Emeritus), at M.I.T., will be the subject of the New England District meeting at the Northeastern University, Boston, Mass., on April 10. Prof. Lewis is one of the outstanding chemical engineers in the country, and was a major factor in the development of chemical engineering as known in the United States. He has been extremely active in all phases of the field, but has made exceptional contributions in the processing and utilization of fuels.

"Civilized living depends upon the utilization of nature's stores of energy—What are they? How do they fit into the pattern of our industrial economy?" These will be some of the points brought out in Prof. Lewis' talk.

A dinner will precede the meeting, and reservations can be made through E. N. Downing, General Electric Co., 920 Western Ave., West Lynn, Mass. Price, $2. President J. G. Morrow and Executive-Secretary, C. L. Warwick from Headquarters will talk informally during the dinner hour. Dinner will start at 6:30 in the Commons Room, with the technical session beginning at 8 P.M.

Arrangements for this meeting have been handled by Program Chairman H. H. Lester, Chief of the Research Division of the Watertown Arsenal. Prof. Walter C. Voss of M.I.T., the Technical Chairman, will introduce Prof. Lewis.

Other District officers and members cooperating in the meeting include Miles N. Clair, Emil A. Gramstorff, Carl G. Lutts, and E. N. Downing.

Western New York-Ontario, April 21, Functional Photography:

The Western New York-Ontario District has arranged for a joint meeting with the Niagara Peninsula Branch of the Engineering Institute of Canada to be held on Friday afternoon and evening, April 21 at St. Catharines, Ontario, Can. During the afternoon, visits will be made to either the Ontario Paper Co. at Thorold, Ontario, one of the largest paper making plants in the district, or the Decew Falls power station of the Hydro-electric Power Commission of Ontario which was only completed during the recent World War.

Between the afternoon plant visits and the evening technical session, a dinner will be held at the Hotel Queensway in St. Catharines.

The technical session, also at the Hotel Queensway, will feature a talk by Mr. George Eaton of the industrial Sales Division of the Eastman Kodak Company in Rochester, on "Functional Photography." His talk will be illustrated by the new Eastman film, "Functional Photography in Industry."

Mr. O. W. Ellis, chairman of the A.S.T.M. District, has arranged for this meeting in cooperation with Mr. C. Climo, Vice-Chairman of the Niagara Peninsula Branch of the E.I.C. Direct mail notices concerning this meeting will be sent to all members of the A.S.T.M. and E.I.C. districts, with return forms for dinner and plant visit reservations.

St. Louis, March 28, Stress Analysis:

The St. Louis District and the Engineer's Club of St. Louis held a joint meeting on March 28 at the Engineer's Club of St. Louis at which Mr. Wm. T. Bean, Jr., gave his dynamic lecture demonstration on Stress Analysis in Action. Mr. Bean's lecture involved actual demonstrations of a great deal of equipment, some of it new.

At the dinner preceding the technical session, A.S.T.M. President J. G. Morrow was called upon to bring greetings from the Society, and Executive-Secretary C. L. Warwick also spoke briefly.

Mr. J. M. Wendling, secretary of the St. Louis District, was responsible for the arrangements of this excellent meeting.

The District Secretary, John M. Wendling, City of St. Louis Testing

The May BULLETIN will include some notes on a recent visit to the West Coast by the Assistant Secretary which included meetings in San Francisco and Los Angeles. Luncheon or dinner meetings were also held in several industrial centers in the Northwest and Southwestern areas.

Laboratory, directed many of the arrangements for the meeting in cooperation with S. Blake Roberts, Robert W. Hunt Co., Vice-Chairman. District Chairman Dr. John C. Hostetter was in close touch with the affair while he was making steady progress recovering from a recent illness.

Chicago, March 28, Photography in Industry:

The new Eastman Kodak film, "Functional Photography in Industry," was the main feature of the Chicago District meeting on March 29 at the W.S.E. Headquarters. This 35-minute film in Kodachrome and black-and-white brought to light the tremendous increase in the use of photography in industry and in the scientific and testing fields.

Preceding the film there was a discussion of photography's part in industry by John Niemeyer, Technical Representative of the Eastman Kodak Co. in Chicago. A question-and-answer period, led by Mr. Niemeyer, followed the presentation.

A.S.T.M. President J. G. Morrow, the honored guest of the evening, spoke briefly and was followed by Executive-Secretary C. L. Warwick who touched upon the work of the Society in the fields of spectroscopy and color metallography within our technical Committees E-2, E-4, and E-13, and also covered some phases of the work of Committee E-12 on Appearance.

Textile Wear Resistance Developments—Germany

"Developments in the Wear Resistance of Textiles," a collection of 19 key papers on this and related subjects published in Germany during the war years, is now available to the American public through the Office of Technical Services of the U. S. Department of Commerce.

The collection, a cloth bound volume of 353 pages, was compiled at the request of the Chief Quartermaster, U. S. Army European Command, to summarize significant German researches on fiber behavior, a subject of increasing importance with the growing production of artificial textiles.

Topics are: Evaluation of the serviceability and wear resistance of textiles; classification of textile fiber properties; structure and reactability of fibers; and resistance to water and shrinkage.

PB-99296, *Developments in the Wear Resistance of Textiles and Related Papers Published in Germany during World War II*, sells for $5 per copy. Orders should be addressed to the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., accompanied by check or money order payable to the Treasurer of the United States.

Air Pollution Studies Featured at Philadelphia Meeting

It must have been the combination of timely subject, authoritative speakers, and a gourmet's dinner which succeeded in bringing out so many members and friends on such a rainy evening to the last Philadelphia District Meeting.

In the Franklin Institute auditorium, Dr. Louis C. McCabe, Bureau of Mines' Chief of Air and Stream Pollution pointed out that studies on the Los Angeles "smog" nuisance, in Donora, Pa., and on air pollution in general, have started an increasing trend to support a newer theory on the physiological effects of air pollution.

Dr. McCabe voiced the essence of this theory—that the wholesale disability which sometimes occurs in towns and cities exposed to industrial fumes may often be the result of combined action on the body of the numerous waste substances in such atmospheres. Aldehydes, Dr. McCabe said, are known to cause eye irritation when present in 1 to 4 ppm. Similarly, certain chlorinated hydrocarbons and sulfur dioxide, each have a minimum concentration necessary to produce a disagreeable effect. In the Los Angeles smog, aldehydes and sulfur dioxide were present each only in 0.4 ppm. But it is thought that the eye irritation and destruction to lettuce crops may have been due to this combined action of the several waste products.

After his introduction by Drew Betz (acting as Technical Chairman in the absence of Dr. Fieldner who was unable to attend the meeting because of illness), Dr. McCabe began his lecture by noting that air pollution is relatively new when compared to stream pollution. There is a sharper focus, he said, on air pollution—more interest by the lay public than was evident concerning the older nuisances. He attributed this interest in part to unfortunate incidents such as the Donora affair which have been greatly publicized by the means we have today—newspaper, television, and radio. Also, from 1937 to 1947, as our production has expanded 200 per cent, the smokestacks responsible for that production have poured out volumes of smoke and fumes proportional to this increase.

In speaking of Los Angeles smog and its abatement on which the Los Angeles County Air Pollution Control District worked from 1946 to 1949, Dr. McCabe emphasized that particular meteorological conditions and geological formations are sometimes responsible for the existence of smogs. In general, he said, the atmosphere tends to cleanse itself by a general process of diffusion of waste gases through an atmosphere whose density and temperature decreases as height of observation increases.

Occasionally this "natural" condition may be altered if a warm air mass from a high-pressure area is carried by a mild breeze so that it caps some valley—or trough-like terrain. In such cases there is little turbulence to cause mixing of the cold dense bottom layer in the depression and the warm light upper layer. The interface of the layers acts as a wall, and if this so-called temperature "inversion" lasts, all the particles of smoke and fume of size 0.4 μ to 0.6 μ are trapped as "blue" haze or smog in the bottom stratum.

Measurements made from an airplane showed that this bottom layer, around Los Angeles, extended from the ground to 2000 ft., at times, with an average temperature of 75 F. Above this the temperature was at first much warmer (100 F.) but decreased as elevation increased. Dr. McCabe showed colored photographs which clearly showed the interface between the smog and normal layer above it.

When a smog stratum has been moved along only by a 3- to 4-mph. wind, the accumulated smoke and fumes of the smog have damaged lettuce and other crops around Los Angeles to the extent of one quarter of a million dollars, three or four times a year.

Dr. McCabe pointed out that some of the sulfur dioxide wastes may be oxidized by ultraviolet rays from the sun to sulfur trioxide and that these with moisture may produce sulfurous and sulfuric acids.

Stanford University has been working on a theory that the pollution adsorbed on dust particles may produce the eye irritation of the Los Angeles smog. Some of their experiments have shown that the pollution in an artificial dust or oil fog has produced effects similar to those observed on crops and in the eyes of those exposed to the Los Angeles smogs.

In discussing the developments of standards to aid in air pollution abatement, Dr. McCabe indicated that the problems will be difficult since meteorological and topographical conditions of cities vary and much work still has to be done in the measurement of pollution sources, the distribution of the pollution, and the concentration of it at ground levels. Instruments must be developed (and perhaps major contaminants selected to measure as

indices) the pollution. He mentioned dust-fall measurement, sulfur dioxide recording, and recording visibility meters.

W. B. Hart, Superintendent of Services, Atlantic Refining Co., at the dinner gave significance to Dr. McCabe's remarks by outlining the newer concept of Public Health—devoted to the precept of maintenance of mental and physical well-being of the individual and not merely to the idea that absence of disease is the criterion to be followed. Mr. Hart explained that significant air pollution regulations have been appearing only for the past two years, while stream pollution laws have been in effect for a much longer time. For this reason, he said, air pollution workers should look to the stream pollution experts for valuable experience—the social, political, and economic problems may be very similar even if the technical ones are different.

Certainly Drew Betz and Gustaf Soderberg, program committee, did a fine job in planning for this meeting and A. O. Schafer and his District Council deserve much credit for arranging it.

Electronics Research at New York Meeting

AN ATTENDANCE of about 150 greeted Edwin A. Speakman, Executive Director, Committee on Electronics, Research Development Board, Department of National Defense, at the joint meeting of the A.S.T.M. New York District, and the A.S.M.E. Machine Design Division, on Friday, March 24, at the Engineering Society's Bldg. Mr. Speakman described the important research work being done in the field of electronics and the vital bearing it has on National Defense. An abstract of Mr. Speakman's talk appears elsewhere in this BULLETIN.

The Technical Chairman of the evening was Col. M. B. Chittick of the American Mineral Spirits Co. Col. Chittick is also Commanding Officer of the 1996th Officers Reserve Research and Development (Training) Group, and there was a good representation of this organization present at the meeting.

Following Mr. Speakman was the showing of the new Eastman Kodak film, "Functional Photography in Industry," which was enjoyed by everyone. This is the same film that was shown in Chicago on the 29th, and will be shown at the Western New York-Ontario meeting on April 21.

Arrangements for this meeting were handled by E. P. Pitman, Program Chairman, and Col. M. B. Chittick for A.S.T.M.; and H. C. R. Carlson, Chairman, Machine Design Division, and Prof. C. Higbie Young, Vice-Chairman, for the A.S.M.E.

Electronics Research for the Department of Defense

Abstracts of Address By Edwin A Speakman[1]

RESEARCH AND DEVELOPMENT BOARD

IN DESCRIBING the function of the Research and Development Board, I shall dwell briefly on the structure, duties, and some of the achievements of the board. Then we shall consider the work of the Committee on Electronics with specific examples which will enable you to see how research and development are related to military plans and strategy. The board was created by the National Security Act of 1947 so that it has been in existence for only about four years. The Board itself is composed of the Chairman, William Webster, Executive Vice-President of the New England Electric System, and one military officer and one civilian representing each of the military departments.

Committees:

There are 16 committees under the board, each committee having cognizance over a technical field or type weapon. The scope and variety of work are indicated by the fields covered: Aeronautics, Atomic Energy, Basic Physical Sciences, Biological Warfare, Chemical Warfare, Electronics, Equipment, and Materials, Fuels and Lubricants, Geophysics and Geography, Guided Missiles, Human Resources, Medical Sciences, Navigation, Ordnance and Technical Information. The chairmen of these committees include such well-known names as Robert C. Swain, Vice-President of the American Cyanamid Co.; E. P. Brooks, Vice-President of Sears, Roebuck and Co.; Donald A. Quarles, Vice-President of Bell Telephone Laboratories; W. M. Holaday, Director of Research for Socony-Vacuum Oil Co.; and Frederick L. Hovde, President of Purdue University, to name but a few. Each committee is composed of representatives from the military departments and outstanding civilian experts, one of whom is the chairman. Under the committees, panels are formed, such as the Radar Panel of the Committee on Electronics, also with a mixed military and civilian representation. Supporting the board, the committees, and the panels is a permanent secretariat also made up of civilian and military personnel. Thus throughout the board structure there is joint representation that combines civilians and representatives of the three departments. In all, the board has the services of some 1500 part-time civilian consultants, committee members, panel members, and consultants extraordinary. Of these 1500, all but 280 serve without compensation. They are all recognized leaders and authorities in their fields of science and engineering.

Primary Mission of the Board:

The basic purpose of the board is to bring about a research and development program in the military departments that will do most to promote our national security. More specifically, the board is directed: (1) to prepare a complete and integrated plan for research and development for military purposes, (2) to advise with regard to trends in scientific research relating to national security, (3) to recommend measures of coordination of research and development among the military departments, (4) to formulate policy for the Department of Defense in connection with research and development matters, (5) to consider the interaction of research and development and strategy, and to advise the Joint Chiefs of Staff in connection therewith, and (6) to perform such other duties as the Secretary of Defense may direct.

The coordination of all military research and development performed by the government as well as industrial laboratories requires comprehensive study since about 500 million dollars are involved in the program. However, this amount represents a little more than one cent out of every dollar which we pay in Federal taxes. Stated in another way, research and development take a little less than four cents out of every dollar spent by the Department of Defense.

Achievements:

The board feels that it has by no means achieved its full goal with respect to smooth operations and effective procedures. Where adjustments in program emphasis and support are neces-

[1] Executive Director, Research and Development Board, Department of Defense. The address was presented before the New York District of the American Society for Testing Materials, the Machine Design Division of The American Society of Mechanical Engineers and the 1996th Organized Reserve Research and Development Unit of the U. S. Army, March 24, 1950.

sary in order to bring about a properly balanced program, the board must make them with full consideration for over-all efficiency and national security.

A great deal has been accomplished, however, within the brief period of the board's existence. Aircraft that can travel faster than sound, long-range radar, guided missiles with increasing ranges and greater accuracy, and submarines that can "breathe" under water for indefinite periods of time are a few of the potential weapons on which material progress has been made since the close of the War. In addition, for the first time the board has recently made available to the Joint Chiefs of Staff a complete report on the status of every research and development item which may be important in future military strategy.

Thus far we feel we have been able to maintain a fair margin of superiority in virtually every area of weapon development, but our potential enemy is making remarkable progress in the accumulation of scientific knowledge and the development of engineering techniques. We know that only by prosecuting vigorous research and development programs during peacetime can we hope to maintain technical superiority in the weapons and equipment for our fighting forces.

Board Organization

Department of Defense:

The Department of Defense is made up of the Joint Chiefs of Staff, Research and Development Board, Military Liaison Committee, Munitions Board, Personal Policy Board, and the Army, Navy, and Air Force departments all reporting to the Secretary of Defense.

Research and Development Board:

The Board is supported by Army, Navy, and Air Force Secretaries who are responsible for liaison with their respective departments. In addition there is a permanent staff organization consisting of a Programs Division which collects and summarizes information, a Planning Division which prepares plans and estimates, and the Committee Secretariat. These groups number 300 full-time people, most of whom are professional people.

Committees:

There are 16 technical committees made up of about 1500 part-time military and civilian members. The scope of their activities is indicated by their titles which I have already mentioned.

Electronics:

The Committee on Electronics consists of ten panels made up of civilian and military experts.

The Panel on Acoustics is concerned primarily with the transmission and reception of sound in air and in water. Fundamental studies are being conducted on submarine listening devices and sonar equipment used to track down and destroy enemy submarines.

The Panel on Antennas is concerned with the radiation and propagation of radio energy, sometimes over long distances as is the case for early warning radar nets and sometimes in sharp beams at shorter distances as required for tracking and fire control of guns and missiles.

The Panel on Communication has for its field of interest not only those items that are popularly recognized as communication such as radio, telephone, and telegraph equipment but all items which convey intelligence from one point to another. The field, therefore, includes facsimile, television, data transmission, and telemetering devices.

The Panel on Components is concerned with all types of electronic components such as resistors, coils, capacitors, transformers, and piezoelectric crystals. The people on this panel are interested in improving the reliability, versatility, and availability of all components with special emphasis on miniaturization. Research and development in this field are fundamental to all work in electronics.

The Panel on Electronic Countermeasures is concerned with new techniques of intercepting, analyzing, and jamming all types of radio signals throughout the radio spectrum. This includes direction finding, high-power jammers, and special deception devices to produce false radar targets.

The Panel on Electron Tubes concerns itself with all phases of research and development on all types of electron tubes from the smallest of the subminiatures to the largest of the super power magnetrons. Switching tubes, gas tubes, cathode-ray tubes, traveling wave tubes, and storage tubes are all included as well as the more common transmitting tubes and receiving tubes of conventional design. Also included are devices which take the place of electron tubes such as crystal diode rectifiers and the new "transistor."

The Panel on Interference Reduction covers means and methods of reducing interference at its source and the effects of interference, instrumentation for the evaluation of interference, and standards of measurement of interference. In its broadest sense this may be interpreted to include atmospheric and other natural forms of interference, unintentional man-made interference (from engines of all sorts, electromechanical devices, etc.), and intentional interference (jamming).

The Panel on Infrared covers techniques in that portion of the spectrum between visible light and radio waves from 0.1 to 1000 microns. Applications include communication, navigation, detection, and ranging. For example, recent developments make it possible for the operator of a truck to drive with safety along roadways in complete darkness and at a speed of at least 25 miles per hour. It will permit a pilot to land an airplane on a runway that is marked out with infrared sources that could not be seen at all unless the pilot had an infrared binocular device. Boats can be brought to the shore or to the mother ship under dark-out conditions with the only means of seeing the shore or the ship being the infrared telescopes.

The Panel on Radar includes in its field of interest long-range early-warning radar, fire control and missile-guidance radar, bombing radar, identification and recognition, and other special techniques. One of these concerns the detection of high-altitude planes and missiles and the control and direction of our own airplanes to intercept enemy planes and missiles. The use of information from ground radar equipments as a navigational aid during low visibility has been in actual use for some time. The so-called GCA ground control approach system for aircraft is highly successful and is used regularly at various airports to "talk down" pilots to safe landings. Its usefulness was amply demonstrated in the Berlin airlift.

The Panel on Test Equipment covers all types of test equipment required for new electronic equipments and for research. Under this panel comes the primary responsibility for assuring adequate electronic tools.

Electronic Countermeasures

On February 11, 1941, the German battle cruisers, the *Gneisenau*, *Scharnhorst*, and *Prinz Eugen*, made their escape through the English channel from Brest. The British had the channel completely covered by radar, but their signals were so successfully jammed by German signals that no radar echoes were obtained from the German ships. This was the first significant operational use of countermeasures. The second operation occurred in 1944 as a result of our jamming against German antiaircraft radars. The enemy relied very heavily on antiaircraft guns—some 15,000 heavy guns controlled by some 3000 fire-control radars. This presented a formidable obstacle since our bomber losses at that time were rather high. An Allied countermeasure program was started in the fall of 1944. Jammers were installed in our bombers

to jam the German ground fire control radars.

Two things resulted:

1. The German radar-controlled guns were rendered almost useless.

2. Ninety per cent of all German technical personnel were transferred to anti-jam work. This disrupted the German electronic research program so that the Germans were never able thereafter to catch up to our developments in microwave techniques.

The electronic countermeasure program was therefore extremely important, not only in an operational way, but also in preventing the enemy from undertaking new developments. He was placed completely on the defensive in the electronic field. Our present program in countermeasures continues much of the research aimed at jamming and destroying the usefulness of enemy radio signals. In addition, one of the most important countermeasure techniques is that of interpreting and analyzing enemy transmissions. There are various means of sending secret messages. In the last war the German submarines communicated with their home base by means of extremely short flash type signals on the air for only a fraction of a second. These are difficult to receive unless one knows in advance the precise frequency and direction of the signal.

Other techniques include schemes of deception. For example, a code signal of above audible frequency may be superimposed upon a standard broadcast signal. Such signals must be recorded and then analyzed at slower speeds to discover the intelligence.

We know that a radar transmitter puts out a powerful signal. Such signals can be received and used to detect the presence of enemy radars.

Ripple Tank:

In the transmission and reception of radar and radio signals, it is necessary to have an antenna or means of radiating electrical energy in sharp beams so as to direct all available energy in the desired direction. The antenna must be designed with great care and the problem of plotting the antenna pattern and of measuring phase-front linearity is very tedious by conventional means. There is need for a simple analog device to aid visualization. The ripple tank is a device that has been used extensively to demonstrate two-dimensional phenomena. As a result of work by A. H. Schooley of the Naval Research Laboratory, an electronically driven ripple tank has been devised and applied to antenna problems.[2]

TECHNICAL COMMITTEE NOTES

H. F. Schiefer Receives Harold DeWitt Smith Memorial Medal

ON THURSDAY afternoon, March 16, in connection with the meeting of Committee D-13 on Textile Materials, the first award of the Harold DeWitt Smith Memorial Medal was made to Dr. Herbert F. Schiefer, Physicist at the National Bureau of Standards.

This medal has been established through funds contributed by the Fabric Research Laboratories in Boston, and is to be given annually—or at longer intervals—by Committee D-13 as a testimonial to the memory of Dr. Harold DeWitt Smith. It is given for outstanding achievement in, or contribution to, the science of the utilization of textile fibers and structure or methods for the evaluation of their properties.

As part of the presentation ceremony, Richard T. Kropf, Vice-President and Director of Research, Belding-Heminway Co., spoke briefly on "The Medalist—The Man," and W. D. Appel, Chief of the Textiles Section, National Bureau of Standards, spoke on "The Medalist—The Scientist."

The presentation of the citation and medal was then made by Prof. H. J. Ball, as Chairman of Committee D-13.

In accepting the Medal Award, Dr. Schiefer spoke briefly. He expressed sincere thanks and appreciation for the very high honor. He was impressed with the great responsibility and trust so intimately and closely associated with the Harold DeWitt Smith Memorial Medal. He accepted the Award with "...solemn resolve to foster, promote, and uphold the ideals, leadership, integrity, open-mindedness, and scientific viewpoints of Harold DeWitt Smith, and with great humility...."

Herbert F. Schiefer

(From introductory remarks by Messrs. Kropf and Appel):

Dr. Schiefer received his Baccalaureate degree in 1924 from the University of Michigan. With his Masters degree in 1925 in Mathematics, he became a member of the faculty of the Department of Astronomy. In 1928, soon after receiving his Ph.D. degree in Astrophysics, he became Professor and Head of Mathematics and Physics at Des Moines University in Iowa. During these years he was a member of honor societies, such as Tau Beta Pi and Sigma Xi.

In 1929, Dr. Schiefer accepted the invitation to join the Textile Section of the National Bureau of Standards. At that time the Bureau was in need of a scientist trained in physics and mathematics to undertake research on textiles. Physicists were practically unheard of in the textile industry and the Bureau had turned to the universities for a candidate.

Schiefer was and is a true pioneer in textile science and technology. His publications deal with such diverse subjects as the mechanical properties of cotton yarns, factors affecting the performance of silk hosiery, household blankets, thermal insulating value of fabrics, crush-resistant finishing treatments, air permeability, and flexural fatigue. He has created or developed and described in the literature—the Schiefer flexometer, crompressometer; tautness meter; hosiery, carpet, and cordage wear testing machines; and the Schiefer abrasion testing machine. He has published over 60 technical and scientific papers.

In all of this work, the mind of the scientist is clearly indicated in the planning of the experiments, the use of the newest electronic instruments, the use

[2] Allen H. Schooley, "The Ripple-Tank as an Aid to Phase-Front Visualization". *NRL Report 3559*, Naval Research Laboratory, October 15, 1949, Washington, D. C.

of statistical methods in obtaining and interpreting results, and the caution in making conclusions. The recently developed abrasion testing machine is rooted so firmly in sound physics and mathematics that it is proving applicable in numerous ways not thought of during its development and to many materials other than textiles. The end of this contribution is not yet in sight.

Notwithstanding his impressive academic and personal record, Dr. Schiefer has continued to maintain a well-balanced viewpoint. Among his outstanding personal attributes is his understanding of the human side of a problem. His kindness, generosity, and keen sense of humor are well known to those with whom he has been associated.

Harold DeWitt Smith

(Remarks made by A. M. Tenney, longtime friend and associate of Dr. Smith at a luncheon preceding the award to Dr. Schiefer):

"Once upon a time there was a small boy about six or seven years of age. He and a playmate of about the same age discovered some distance from their homes a bed of beautiful violets. They were thrilled at this discovery, and planned to keep the whereabouts of the violets a secret, so that they could have them all, to which end they covered the bed with leaves, intending to go back in a short time.

"When they returned, however, the leaves had smothered the flowers and there were none to be had.

" 'That,' said Dr. Harold Smith, 'even at so young an age, was a great lesson to me that one cannot have a possession solely his own—that it must be shared with others to assume him lasting satisfaction.'

"Dr. Smith in his Marburg Lecture, 'Textile Fibers—An Engineering Approach to Their Properties and Utilization,' ploughed the ground and planted the garden, the flowers of which will be shared by all of us for many generations to come. As an old friend, I am sure he would have liked to have me express his thanks to those who have endowed the award, The Fabric Research Laboratories, Inc., to the members of Committee D-13 for sponsoring and perpetuating its existence, and to the present Award Committee, who have so wisely chosen Dr. Herbert F. Schiefer as the first recipient of the Harold DeWitt Smith Memorial Medal. As far as we can see into the future, Harold's friends have made it possible for the continuation and public recognition of the creative work in textile evaluation, which he so nobly pioneered."

Conference on Radioactive Isotopes:

A Conference on Radioactive Isotopes was held in Pittsburgh on March 2 to determine the interest in the establishment of a separate committee on the use of radioactive isotopes in testing. Participants at the conference heard information presented by Dr. George G. Manov, Chief, Advisory Field Service Branch, Isotopes Division, Atomic Energy Commission, Oak Ridge, Tenn.

Dr. Manov pointed out that at the present time there are 750 laboratories employing approximately 3000 to 4000 trained personnel. In addition, there are some 20 consulting laboratories and 50 to 75 industrial users of radioactive isotopes. Since the inception of the isotopes distribution program three years ago, 10,000 shipments of more than 100 different isotopes have been made.

Brief mention was made of a number of applications, including radioactive piston rings for checking engine wear, friction studies, fluid flow through pipes, thickness gages for paper, oil-field drilling, paint films, and migration of alkalies in, and sulfate resistance of, cements and concretes.

Dr. Manov also mentioned the various conditions set down by the A.E.C. in regard to the allocation of isotopes and the suggested safety measures to be em-

Daily News Record Photo

Front Row (Reading for left to right): Mrs. W. H. Whitcomb, Prof. H. J. Ball, Mrs. Herbert F. Schiefer, Mr. Herbert F. Schiefer, and Mrs. Harold deWitt Smith. Second Row: R. T. Kropf, G. H. Hotte, A. G. Scroggie, W. H. Whitcomb, G. E. Hopkins, W. J. Hamburger, W. D. Appel, A. G. Ashcroft, A. M. Tenney, Frederic Bonnet, K. L. Hertel, and J. S. Jacobs

ployed in handling them. These safety measures range from ordinary fume hoods, "glove-boxes" and respirators for the handling of Carbon-14 to lead-glass or lead bricks for the gamma emitters such as Cobalt-60.

Among those attending the conference were pioneer users of radioactive isotopes in testing and representatives of a large number of various A.S.T.M. Committees. Many of those present spoke briefly of their experiences. The numerous comments made indicate that extensive use of radioactive isotopes is being made in industry, including process control, such as thickness and liquid-level gages. Other examples are the determination of the wear of electrical contacts, treatment of wood poles, corrosion, bleeding of bituminous materials, analysis of blast-furnace gases, wetting agents, various chemical reactions and sulfur in coal.

In view of the broad interest in diversified fields of many methods of testing using radioactive isotopes, it was the consensus that the Board of Directors should give consideration to the organization of a new committee on radioactive isotopes.

Committee Week (*continued from page 10*)

Committee C-16 on Thermal Insulating Materials held its three-day meeting. Reports submitted by the several subcommittees generally denoted progress in the several types of materials covered by the committee. Four new tentatives for block and pipe insulation have been prepared for presentation to the committee. The Subcommittee on Structural Insulating Board was instructed to prepare a definition of this product either by describing its structural qualities or by its maximum condictance. The first draft of tentative specifications for mineral wool felt, industrial batt insulations, and blanket insulations with metal mesh covering has been prepared. Two additional preliminary drafts have been prepared covering mineral wool blanket-type pipe insulation and mineral wool molded-type insulation. A test method for determining density of loose fill insulation is being reviewed by a subcommittee as well as a laboratory method of test for corrosion.

Two alternate proposed methods for measuring thermal conductivity of pipe coverings were discussed, and it is expected to have a proposed tentative ready at the time of the fall meeting. In the field of special thermal properties, proposed methods of test for specific heat and emissivity are being prepared with progress slow in setting the temperature limits on high-temperature block. A very comprehensive survey has been completed on the establishment of tolerances in pipe coverings in which some 40,000 readings have been taken. Tables and graphs have been prepared and action was approved to submit this information as a proposed recommended practice for dimensional standards for pipe coverings. Further progress in the study of vapor permeability has been delayed pending conclusions arrived at by the task group of Committee E-1. It was the consensus of this subcommittee that it was within the province of the committee to establish limits on permeance and study will be given to this.

A subcommittee has been appointed to plan a symposium consisting principally of papers on special thermal properties. This symposium will be presented at one of the A.S.T.M. meetings in 1951 and papers are being solicited. The fall meeting of the committee is planned to be held at the Berkeley-Carteret Hotel, Asbury Park, N. J., during the latter part of October.

C-18 on Natural Building Stones:

(*Washington—March 17*)

Considerable time was spent in the discussion of specifications at the meeting of Committee C-18 on Natural Building Stones held at the National Bureau of Standards, Washington, D. C., on March 17. A Proposed Specification for Exterior Marble was reviewed, but no action was taken to recommend this as a new A.S.T.M. tentative pending further research work by both marble producers and the National Bureau of Standards. Editorial changes were accepted in the definitions of granites and new definitions covering flagstone and soapstone were suggested. A proposal to establish three grain-size classifications for granite was accepted for presentation to the granite producers for preliminary review. A recommendation for immediate adoption subject to letter ballot was made covering revisions of the Methods of Tests for Compressive Strength of Natural Building Stone (C 170) to include specimens which are shorter than the present ratio of height to lateral dimensions. This will allow specimens to be tested which differ by more than 25 per cent from the one-to-one ratio provided a conversion formula is used.

Action was taken to assign to the research subcommittee the responsibility of reporting yearly on observations made of the test wall which has just been completed on the grounds of the National Bureau of Standards. It is expected that in this way a permanent and continuing record will be assured covering the valuable information which can be expected over a period of a considerable number of years on the weathering of the many types of natural building stones. An inspection of the exterior test wall was made by those present following the adjournment of the meeting.

C-21 on Ceramic Whitewares:

The meetings of Committee C-21 on Ceramic Whitewares included that of the main committee and the Subcommittees on Methods of Tests and Research. The initial efforts of this new committee are in the form of presenting a set of definitions which have now been approved by the subcommittee and will be balloted on by the main committee. These definitions represent an achievement which has taken considerable time and effort on the part of the subcommittee. In the formulation of test methods the activity at the present time is centered in the section covering product test methods. Existing A.S.T.M. standard test methods have been reviewed and four have been adopted for use, three being from the refractory group and one pertaining to mineral filler analysis. The Subcommittee on Research has been organized and projects assigned to each member. Initial ways and means of getting needed research accomplished and keeping abreast of technical developments and publications are being worked out. The next meeting of the committee will be at the fall meeting of the Whitewares Division of The American Ceramic Society.

At the conclusion of the business meeting a paper on research was presented by C. G. Harman of the Battelle Memorial Institute.

C-22 on Porcelain Enamel:

Committee C-22 on Porcelain Enamel and its subcommittees held meetings over two days, these being the first of the new committee since its organization. They provided an excellent opportunity for the completion of subcommittee organization and planning for work projects. For the time being decision was made to combine the sections on raw materials and processing in the Subcom-

mittee on Methods of Test. Another point of interest in connection with these sections is that frit will be considered as a raw material and no attention will be given to materials which go into frit at this time. The policy agreed upon by the section on products is to limit its work to test methods which will include those adaptable to consumer goods. Specifications will not be considered at this time because of the need of strong basically sound test methods.

The Subcommittee on Research has canvassed its membership for proposed topics with replies being received covering 30 items. Six of these were selected for immediate consideration. The glossary on porcelain enamel terms published by The American Ceramic Society will be reviewed and revised by the Subcommittee on Nomenclature. The present officers were re-elected for the ensuing two-year term. The next meeting of the committee is tentatively planned for October 12 and 13 at the Westinghouse Electric Co. plant in Mansfield, Ohio.

D-1 on Paint, Varnish, Lacquer, and Related Products:

A Panel Discussion on Colorimetry featured the three-day meeting of Committee D-1 on Paint, Varnish, Lacquer, and Related Products. Walter Granville, Container Corp. of America, served as moderator of the panel discussion. The other members were A. E. Jacobsen, M. P. Morse, R. S. Hunter, E. J. Dunn, Jr., and Francis Scofield. The purpose of the discussion was to bring to the attention of members of the committee and others interested the most recent techniques and thinking regarding color measurement and specifications and control as applied to paint and paint materials. The discussion at this meeting showed that the use of instruments, not only spectrophotometers but others, in color matching and color control has increased greatly in the last decade, and this is expected to continue. It was indicated that some paint companies most vitally interested in color control for paint do not use instruments but rely entirely on retained samples of color visual comparison. The principal problem with regard to measurement by instrument, concerns illumination and viewing conditions in colorimetry, that is, measurements now being made are of such accuracy that variations in the surface characteristics of samples are bothersome to the accurate measurement of small color differences. It was quite evident from the discussion that people will always be concerned by small color differences, and it is to be expected that even closer matching of colors will be demanded until experience devises tolerances that are practical.

In addition to the main meeting of Committee D-1, meetings were also held of some 65 subcommittees and working sections and groups over the three-day period. This large number of meetings is an indication of the activity in the committee in considering the variety of technical problems regarding the testing and evaluation of paint and paint materials.

Committee D-1 cooperates very closely with the Federation of Paint and Varnish Production Clubs. At a meeting of the Joint Federation—A.S.T.M. Committee, it was pointed out that some 31 A.S.T.M. methods and specifications have now been approved as Federation standards. The Federation is considering for approval some additional A.S.T.M. standards, and Committee D-1 is studying several methods submitted by the Federation.

It was announced that the new Subcommittee on Printing Ink has been organized and that the committee had held a meeting in Atlantic City on November 3. The officers of the printing ink subcommittee are: Chairman, P. J. Thoma, Time-Life, Inc.; Vice-Chairman, G. L. Erikson, Braden-Sutphin Ink Co.; and Secretary, A. C. Zettlemoyer, National Printing Ink Research Institute. Some seven working groups have been organized on the following subjects: Definitions, Methods Review, Fineness of Grind, Rubproofness, Printing Ink Rheology, Paper Ink Relations, and Drying Time. The next meeting of the printing ink subcommittee will be held in June.

New tentative methods for determining hydroxyl number and for break test of drying oils were accepted for subsequent addition to standard methods D 555. Work is continuing on studies of procedures for determining diene value and on a revision of the foots test.

The Subcommittee on Cellulosic Coatings submitted a new tentative method for cold test checking of lacquers; also new specifications for diisobutylene and for methanol. The subcommittee plans to review extensively the general methods of sampling and testing lacquer solvents and diluents (D 268 - 49), and the various test procedures now included therein will be published separately.

An important new activity is the initiation of work on the development of a test for flash point of paints, varnishes, lacquers, etc., by the Tag open cup tester. This will include consideration of the Bureau of Explosives' method and the Association of American Railroad's test procedure.

The new Subcommittee on Electrometric Testing of Films presented a proposed method for conducting a time potential test. Work is continuing on the study of the measurement and significance of changes in the electrical resistance of paint films.

A new tentative method for determining heptane number has been completed. There is considerable interest in this new test for determination of the solvency characteristics of high solvency hydrocarbon solvents for resins. Two test procedures for determining Kauri-butanol number of hydrocarbon solvents were also accepted for letter ballot vote. The solvents subcommittee is continuing further work on naphtha solvents and copper corrosion.

The Subcommittee on Painting of Metals is undertaking a program covering the painting of aluminum and its alloys and the painting of galvanized steel, and also the identifying of paints for various surfaces.

New specifications are in preparation for calcium carbonate pigment, and revisions in the Standard Specifications for Magnesium Silicate Pigment (D 605 - 42) are in preparation. The specifications for iron oxide pigments are also being reviewed. The Tentative Specifications for Copper Phthalocyanine Blue (D 968 - 49 T) were recommended for adoption as standard.

The Subcommittee on Optical Properties reported progress has been made in the preparation of a new method of test for the gloss evaluation of high-gloss finishes having gloss values greater than 80 by Method D 523. A test for low-gloss finishes and an 85-deg. sheen test is in preparation. The subcommittee plans to recommend adoption as standard next year of the Tentative Method of Test for Specular Gloss of Paint Finishes (D 523 - 48 T). A study is being undertaken of tests for determining small color differences.

The Varnish Subcommittee submitted as tentative, a new test for determining dust-free drying time by use of cotton flock and also a test for tack by the Zapon tester. A Kauri reduction test for varnishes and a revision of the viscosity test using Gardner-Holt tubes was submitted for inclusion in Method D 154. Viscosity conversion data for the several flow cups have been prepared and will be submitted in the form of a paper for publication in the ASTM BULLETIN. A new tentative method of test for viscosity of paints, varnishes, and lacquers by the Ford viscosity cup was presented for letter ballot of the committeee as tentative. This method has been prepared in cooperation with the Chicago Paint and Varnish Production Club. New work is being undertaken on a study of print-free test. A new tentative method for flexibility of varnishes of the oleoresins and alkyd types, using

a modification of the standard Kauri reduction test, has been completed.

The Subcommittee on Resins recommended methods for determining chlorine in vinyl resins, total solids (precipitation method), softening point, solvent tolerance of amino acids, and phthalic anhydride in presence of other interfering dibasic acids. The subcommittee is continuing its study of tests for specific gravity, clarity and color of solid resins. A revision was submitted in the Tentative Methods of Testing Bituminous Emulsions for Use as Protective Coatings for Metal (D 1010 – 49 T) covering the stability and water-resistance tests. It was reported that work is under way on test methods for coal-tar-base emulsions and on asphalt-base emulsions. It is expected that these will be ready for letter ballot within the year.

A considerable amount of work has been done in the committee on studies of additional tests for physical properties of paint. This includes procedures for oil absorption of pigments, application of uniform films, specific gravity of pigments, hardness of paint films, fire retardance of paints. A new test procedure for measuring dry film thickness of paint applied on magnetic base will be added to the present Method D 1055. New work has been undertaken on a study of a test for wet film thickness and on methods for determining fineness of grind.

The Subcommittee on Shellac has been cooperating with I.S.O. Committee 50 on Lac and Lac Products of the International Standards Organization. In this connection a review has been made of the standards on shellac of the Indian Standards Institute and comments have been forwarded to the I.S.I.

The Subcommittee on Traffic Paints presented a progress report covering this work on studies of accelerated tests for durability and suspension properties of traffic paint. A specification for glass beads for traffic paint is in preparation, and in this connection tests will need to be developed for determining percentage of true spheres, transparency, color, chemical stability, softness, and crush resistance. The present Standard Method of Test for Dry to No-Pick-Up Time of Traffic Paint (D 711 – 48) will be revised.

Several new methods of chemical analysis of pigments have been completed and will be published as tentative in the 1950 Report of Committee D-1. These cover analytical procedures for yellow, orange, and green pigments containing lead chromate and chromium oxide green, blue pigments, and for zinc dust (metallic zinc powder). Additional methods are under development for the analysis of ochres and umbers and also a revision of methods of analysis for basic carbonate and basic sulfate white lead.

The method of conducting exposure tests on wood is being actively studied looking toward improving the present method which covers body paints only and extending the scope to include trim paints. An important accomplishment was the completion of improved record forms for recording exposure test results. The revised forms were prepared in cooperation with the Federation of Paint and Varnish Production Clubs.

D-2 on Petroleum Products:
(Washington—Feb. 19)

The Spring meetings of Committee D-2 and its various technical committees and research divisions held in Washington, on February 19 to 24, reached an all-time high both as to number of sessions held and the number of members in attendance. The meetings extended over six calendar days and sessions were held during the day and in the evening. The attendance was 287 members and guests, and during the six days there were 84 meetings of technical committees, research divisions, and their working sections.

The meetings featured three symposiums. There was also the annual evening meeting with the Navy Cooperative Committee on Fuels and Lubricants.

The first symposium was devoted to the subject of instrument oil and featured a very interesting paper describing "The Behavior of Instrument Lubricants in Tropical Exposure," by Henry Gisser, U. S. Army Ordnance Dept. The paper covered work conducted in the Canal Zone by the Ordnance Department during 1945 and 1946.

The second Symposium was devoted to a full consideration of recent developments in instrumental methods for the determination of tetraethyllead in gasoline. It comprised the following seven papers:

"X-ray Methods in the Analysis and Preparation of Leaded Gasoline," by H. A. Liebhafsky and E. H. Winslow, Research Laboratory, General Electric Co.

"Rapid Polarographic Determination of Tetraethyllead in Gasoline," by K. A. Hansen, T. D. Parks, and L. Lykken, Shell Development Co.

"X-ray Fluorescence Analysis of Ethyl Fluid in Gasoline," by L. S. Birks, E. J. Brooks, H. Friedman, and R. M. Roe, U. S. Naval Research Laboratory.

"Rapid Determination of Tetraethyllead in Aviation Gasoline," by J. C., Bailie, W. J. Tancig, W. E. Delaney, and V. A. Smith, Standard Oil Co. (Indiana).

"A Direct-Reading Polarograph for the Determination of Tetraethyllead in Gasoline," by E. B. Offutt and L. V. Sorg, Standard Oil Co. (Indiana).

"Determination of Tetraethyllead in Gasoline by X-ray Absorptiometry," by G. Calingaert and F. W. Lamb, The Ethyl Corp.; H. L. Miller, University of Michigan; and G. E. Noakes, University of Toronto.

"Monochromatic X-ray Methods for the Determination of Tetraethyllead in Gasoline," by H. K. Hughes and F. P. Hockgesang, Socony-Vacuum Labs.

The third symposium dealt with methods for measuring viscosity at high rates of shear and consisted of the following two papers:

"Viscosity Variation with Temperature and Rate of Shear in Four Lubricating Oils," by S. J. Needs, Kingsbury Machine Works, Inc.

"The Preparation, Properties, and Viscosity-Shear Behavior of API Test Oil Nos. 103 and 104," by M. R. Fenske, The Pennsylvania State College.

These papers give the results of fundamental viscosity studies which have just been completed under the auspices of the Committee on Petroleum Products, of the Division of Refining of the Am. Petroleum Inst.

Announcement was made at the main D-2 meeting of the organization of a new Technical Committee on Petroleum Wax under the joint sponsorship of A.S.T.M. and the Technical Assn. Pulp and Paper Industry. There is considerable interest in the work to be undertaken by this committee because of the need for test methods for wax and particular wax products, such as wax papers. The officers of this technical committee on petroleum wax are:

Chairman, A. M. Heald, Marathon Corp.
Vice-Chairman, R. B. Killingsworth, Socony Vacuum Oil Co.
Secretary, A. P. Anderson, Shell Oil Co.

The D-2 Advisory Committee decided to establish a new Research Division on Calorimetry. It was reported that the Section on Oil Systems of Turbines has now been established under the joint auspices of A.S.T.M. and the Am. Soc. of Mechanical Engrs.

At the Annual Dinner of Committee D-2 this coming year, tribute will be paid to two of its members for their many contributions and long service in the committee work: A. E. Miller, Sinclair Refining Co., and C. A. Neusbaum, Standard Oil Development Co.

Excellent progress was reported on the oil measurement tables which are being

prepared in cooperation with the Institute of Petroleum (London). These tables will represent an important milestone in that they will establish a basis for the buying and selling of petroleum products throughout the world. The calculation work on the tables, which when published will comprise some 1100 pages, has been completed. The extent of the statistical end of this project can perhaps be better appreciated in that the data as calculated fills 6500 pages and required 450,000 calculating machine cards. The cards alone weigh about 3000 lb. There is still a major editorial job to be completed in checking the tables and preparing them for publication.

Another important accomplishment was the completion of material for a new A.S.T.M. Manual on Gaging and Sampling of Petroleum and Petroleum Products. This Manual will include detailed procedures for gaging, temperature measurement, sampling, and information on methods of calculation. The committee has been at work on this manual for the past two years and it will contain the latest practices on this subject for use throughout the many branches of the petroleum industry.

The Research Division on Analysis of Petroleum Products for Hydrocarbon Types has been extremely active during the past year. It presented as tentative a new method of test for the analysis of 60 per cent *iso*octane–40 per cent normal heptane blends by infrared spectrophotometry. The following five methods were also submitted for publication as information with the 1950 Report of Committee D-2:

- Hydrocarbon Type Analysis of Diesel Fuels.
- Bromine Number of Petroleum Distillates (Color Indicator Method).
- Bromine Number of Petroleum Distillates (Electrometric Method).
- Precise Determination of Refractive Index and Refractive Dispersion.
- Density of Reference Fuels by Pycnometer.

In addition revisions were submitted in the test for determination of purity by freezing points to revise the scope to include normal hexane, including the addition of appropriate constants for this material.

There has been a need for a method for determining the boiling temperature ranges of petroleum fractions which decompose when distilled at atmospheric pressure. Cooperative tests have been made on a vacuum distillation method and as a result a new method has now been completed for reduced pressure distillation of petroleum products applicable up to a maximum liquid temperature of 750 F., to the distillation of any petroleum product which starts to vaporize under the pressure of the test at a vapor temperature at least 50 F. above the condenser temperature used in the distillation.

A study has been undertaken of the Tag open cup tester for testing the more highly volatile petroleum solvents. This work will be carried on in cooperation with the A.S.T.M. Committee D-1 on Paint Materials. It will include consideration of the Bureau of Explosives' method and the Association of American Railroad's test procedure.

The Research Division on Corrosion submitted a revision in the Tentative Method of Test for Free and Corrosive Sulfur in Petroleum Products by the copper strip method which will include a table of reference standards for copper strip corrosion. This division is undertaking a study of copper strip corrosion in heavier petroleum products, especially those containing additives.

The Technical Committee on Lubricating Oils reported that it is planning two symposiums for the June, 1951, meeting. The first will be on "High Additive Content Lubricants" and the second on "Lubrication Under Extreme Pressure Conditions."

At a meeting of the Section on Lubricants for Air Compressors and Compressed Air Tools, there was presented a paper by K. M. Hollister, Refinery Department, The Texas Company, on types of compressors and types of lubricants for their lubrication. This paper was recommended for publication in the ASTM BULLETIN. This technical committee is continuing its study of the classification of motor oils. It received at the meeting another proposal from one of the large automobile manufacturers and this is to be given immediate study for report at the June meeting.

The Section on Industrial Gear Oils has also undertaken the preparation of a classification of gear lubricants. It is proposed to base this on a viscosity classification with all viscosities being expressed at 100 F. Some eight grades are proposed.

In view of the increasing use of diesel power in train operation, the Technical Committee on Diesel Fuels arranged a meeting with representatives of the railroads and locomotive builders and at it, discussed mutual problems. As a result, some of the subjects to be considered include the effect of sulfur on engine operation, ignition, quality testing, front-end volatility, deposit forming characteristics, sediment and extraneous materials. In cooperation with the Research Division on Analysis of Fuels, work is to be undertaken on development of a test for gum content of diesel fuel oil. Work is also under way on a study of jet fuels and other fuels boiling above the gasoline range.

The Technical Committee on Grease reported that in view of the widespread interest in the subject of fretting corrosion (friction oxidation) this subject is being explored in order to bring together the available information. It was recommended that Committee D-2 sponsor in June, 1951, a symposium on fretting corrosion. A paper on "Evaluation of Wheel Bearing Grease by the A.S.T.M. Wheel Bearing Grease Tester," by C. W. Georgi, of the Quaker State Oil & Refining Co., was also presented.

The Technical Committee on Light Hydrocarbons submitted for publication as tentative the method of test for boiling-point range of polymerization grade butadiene, published as information in 1949, and also issued as tentative the factors and tables for volume correction and specific gravity conversion of liquefied petroleum gases issued as information in 1948. A new test for carbonyl content of butadiene will be issued as tentative. New work covers a study of a test for specific gravity of liquefied petroleum gases, also a test for sulfur content of butadiene, and inhibitors and pentanes in butadiene.

Of particular significance was the preparation of a set of tables containing physical constants of various hydrocarbons. These data have been compiled following a comprehensive survey of existing data for these materials. The tables are divided into three parts covering: (1) light naphthenes and aromatics, (2) paraffin hydrocarbons, and (3) mono-olefins, diolefins, and acetylenes. Accompanying each part of the tables there is a bibliography. After approval it is proposed that the tables be submitted to the Society for publication as information. The technical committee reported that it is prepared to keep the tables up to date and to make such additions and changes from time to time as become necessary.

The new Coordinating Division on Research held its first meeting and has prepared some suggested research projects to be written up in detail. It is planned to submit the description of these projects for publication in the ASTM BULLETIN, the proposal being that one project might appear in each issue. The projects are of a nature that would be of particular interest to research foundations, institutes, and graduate students in universities.

D-3 on Gaseous Fuels:

New methods of sampling natural gas and a method for measuring water vapor content of fuel gases were completed by Committee D-3 on Gaseous Fuels at its meeting. The two new methods will be companion standards to the three A.S.T.M. standards now available which cover detail test procedures for Calorific Value by the Water-Flow Colorimeter (D 900 – 48), Specific Gravity of Gaseous Fuels (D 1070 – 49 T), and Methods for Measurement of Gaseous Fuel Samples (D 1071 – 49 T).

The methods of sampling natural gas have been completed after several years study. They cover procedures for the sampling of natural gas containing different gases as contaminants such as (1) natural gases containing primarily hydrocarbons and nitrogen, (2) natural gases containing hydrogen sulfide, or organic sulfur contaminants, (3) natural gases containing carbon dioxide, (4) natural gas containing gasoline and condensables. The differences in procedures are mainly in degree rather than in time. The method contains information regarding the size of sample to be used for the following determinations: (*a*) chemical gas analysis; (*b*) specific gravity with balance type instruments; (*c*) heating value determination; (*d*) hydrogen sulfide by Tutwiler method; (*e*) hydrogen sulfide by cadmium sulfate method; (*f*) referee sulfur; (*g*) gasoline content; (*h*) fractionation analysis; and (*i*) superexpansibility tests. These methods of sampling natural gas after approval by letter ballot of Committee D-3 will be submitted to the Society for publication.

The committee also reviewed a draft of Proposed Methods of Sampling Manufactured Gas, which will be further revised and submitted for study. It was also reported that a draft of methods for sampling liquified petroleum gases was being discussed with representatives of the Natural Gasoline Assn. of America and the California Natural Gasoline Assn.

The method for Measuring the Water Vapor Content of Fuel Gases by the Dew Point Method was approved for submission to letter ballot for publication as tentative. This method determines the water-vapor content of fuel gases by the water dew-point temperature of the gas. It applies generally to any properly constructed type of dew-point instrument, but the specific construction and operational features of the U. S. Bureau of Mines type of dew-point instrument are referred to as illustrative. The test is limited to gases whose water dew-point temperature at the test pressure is not lower than the hydrocarbon dew-point temperature of the gas at the test pressure. The range of water vapor contents covered by the method theoretically is from 0 to 100 per cent saturation. Practically, it is limited by the dew-point testing equipment used and under the requirements prescribed is arbitrarily limited (1) to conditions where the water dew point is at least 3 F. lower than the temperature of the source-gas pipe line or container and the ambient temperature of the testing equipment including all pipe lines leading the gas from the gas source to the testing equipment, and (2) to conditions where the determined dew point is not lower than 0 F.

The committee took action to request its Subcommittee on Complete Analysis of Chemical Composition of Gaseous Fuels to prepare detail procedures for the volumetric chemical analysis of gases. It is hoped that the draft of these new methods will be available by the time of the next meeting of the committee in June.

D-4 on Road and Paving Materials:

Committee D-4 on Road and Paving Materials with 13 of its subcommittees held meetings on March 1 and 2. In the reports of the subcommittees the keynote was mainly that of progress. There will be fewer than the usual number of recommendations for presentation to the Society in the 1950 Annual Report. Included in the definite recommendations presented for committee action are a proposed method for the determination of bitumen in paving mixtures using the Rotarex Method and a proposed revision for immediate adoption of the Standard Specifications for Asphalt Plank (D 517). This revision deals with the substitution of a hardness test in place of an indentation test. Several existing tentatives were recommended for retention without change.

A method for determining the resistance to plastic flow of fine bituminous mixtures which uses the Hubbard-Field Stability Test was proposed for subcommittee action. A draft for a new viscosity method has been completed which will be reviewed by the proper subcommittee for presentation to the committee. The reproducibility of this method is now being studied through cooperative tests. The two subcommittees dealing with the effect of water on bituminous mixtures and coated aggregates reported interesting developments in this particular field including the consideration of two methods to aid or eliminate the visual method of examining uncoated areas. These two methods would make use of photographs and a dye absorption method. A proposed new specification to cover a heavy viscosity emulsion for surface treatment is being balloted by the Subcommittee on Emulsified Asphalts. It was proposed to set definite percentage limits upon thin and elongated pieces and other deleterious substances as part of a revision of the specifications for aggregate used in bituminous work.

D-5 on Coal and Coke:

Committee D-5 on Coal and and Coke met on Tuesday afternoon and actions of particular interest included:

1. Termination of a subcommittee on Coal Ignitibility with agreement that no further consideration should be given to method standardization unless and until better definition of the term itself was presented, more was known of the relation between coal's reactivity, ignition characteristics, etc., and its use, or there should be more demand for a commercially useful test of such characteristics.
2. Committee agreement to specify uniform screen sizes for certain tests of coke.
3. Report of significant progress toward revision of the standard methods of analysis by the recently constituted Subcommittee XXI. Methods for determining carbon and hydrogen in coal and coke are now in a stage which should mean final drafts can be prepared, and assignments have been made for the preparation of initial drafts of test procedures for determining nitrogen and for the determination of mineral CO_2 in coal and coke.

D-6 on Paper and Paper Products:
(*New York—Feb. 24*)

A one-day meeting of Committee D-6 on Paper and Paper Products was held in the Conference Room of the American Standards Association in New York City on February 24. Meetings of Subcommittees I, III, and IV followed the main meeting. In Subcommittee I on Paper Testing Methods, numerous proposed test methods and revisions of existing methods were discussed and certain action taken. Editorial changes were approved in the test for organic nitrogen (D 982 T); the proposed method for testing zinc pigments is still incomplete; a method has been completed for covering the testing for lint in connection with paper towels which will be submitted to letter ballot, and three methods of analyzing pinholes in paper are ready for submittal to the subcommittee for comments. Time was given to a review of corresponding A.S.T.M. and TAPPI methods with

prepared reports being given by individual members with recommendations for any further action toward correlation.

The final review was made of the latest draft of the proposed Specifications on Filter Paper for Use in Chemical Analysis. It is expected that this proposed specification will be included in the annual report for acceptance by the committee and the Society. A suggested revision of the Methods of Testing of Analytical Filter Paper (D 981 T) was given to the Subcommittee on Paper Testing Methods.

A joint subcommittee was authorized for coordination between Committee D-6 and Committee D-9 on Electrical Insulating Materials on all standards of joint interest. This is an expansion of the former joint committee on pH problems. The committee will meet during the Annual Meeting of the Society in Atlantic City.

D-7 on Wood:

(Chicago—March 14)

At its meeting in Chicago on March 14, Committee D-7 on Wood received the first reports on two new subcommittees as well as a report from the newly organized section on crossarms. One of these, a new Subcommittee on Methods of Chemical Analysis of Wood under the Chairmanship of Dr. G. J. Ritter, has reviewed all existing chemical methods such as those used by the Forest Products Laboratory, American Chemical Society, and various producer organizations, with a view toward standardizing those which might be acceptable as A.S.T.M. standards. A recommendation was accepted subject to letter ballot proposing tentative methods covering determinations of ash, cold water solubility, hot water solubility, ether solubility, alcohol-benzene solubility, 1 per cent sodium hydroxide solubility, holo-cellulose, alpha cellulose, lignin, and methoxyl. Organization was announced of the other new Subcommittee on Durability Exposure.

The third major development reported was that of the initial consideration of problems in connection with the testing of crossarms. The section reported agreement on a scope for their work based on limiting the size of crossarms, for the purpose of their tests, to pieces of lumber having cross-sections of approximately 4 by 6 in. and in lengths not exceeding 10 ft., primarily for support on single poles. A task group was organized to plan a testing project to include cantilever or simple beam tests, moisture content using dry clear fir, to be saturated and preferably air-seasoned, with test data to be recorded on two common sizes. The testing program on wood poles is still in a proposed status with consideration being given to the best means of raising the necessary funds for conducting this important work. Several other recommendations were made subject to letter ballot of the committee. These include a proposed tentative method of test for determining the integrity of glue joints in laminated structural members for exterior service, a secondary method for inclusion in the Standard Methods of Testing Small Clear Specimens of Timber (D 143) which will allow the use of smaller specimens in static bending and compression parallel to grain determinations, this to be recommended for immediate adoption into the standard, and a new tentative list of tree names of soft woods which will give a comparative list of standard commercial names for lumber and official common tree names. A recommendation was also approved for letter ballot for the adoption on standard of all tentatives accepted in 1949 covering wood preservatives. In the subcommittees, proposed work is planned on a revision of the Specification on Round Timber Piles (D 925) and on a possible grouping of veneer and plywood species by their gravity or other similar characteristics.

Election of officers was held with the present Chairman, L. J. Markwardt continuing in office and Mr. L. Smith, National Lumber Mfgrs. Assn. as Secretary. Memorial resolutions were recorded on two deceased members, F. A. Hartman and C. S. Reeve.

D-8 on Bituminous Waterproofing and Roofing Materials:

Probably the most important accomplishment at the meeting of Committee D-8 was the initiation of work on performance standards. This new approach will mean new test methods and eventually new specifications based thereon. The present specifications are based upon composition.

Work has also been initiated on the development of standards covering insulating siding materials. This material is receiving increasing use, particularly in the renovation of older houses.

The committee is giving attention to the question of nails for use with shingles and roofing in order to determine whether aluminum nails and alloy nails can be used as a substitute for steel nails. It proposes to carry on this study in connection with other interested A.S.T.M. committees.

Architects will be interested to know that studies are now being made on asbestos roofing felt to provide perforation of the felt so that it will not entrap air, one of the difficulties that has been encountered in the past in the use of this material. The committee is also studying the new type of saturated burlap now available in order to provide specifications should this new material prove to be free from the defects of the material used some years ago as covered by specifications at the time but since discontinued.

The committee is also reviewing the present specifications for roofing, waterproofing, and dampproofing to insure that the products presently available in the newer refining process are adequately covered.

The Subcommittee on Accelerated Tests has made considerable progress in establishing the end point in an accelerated test, that is, in determining when a specimen should be considered as having failed. Several papers on the subject are in preparation. This subcommittee is also working on a method for the preparation of test panels for accelerated tests and outdoor exposure. A number of new definitions are being recommended covering terms used in test procedures and dealing with the products.

D-11 on Rubber:

Plans for an International Meeting on Rubber and Rubber Products to be held in Cleveland during the week of October 9 were discussed at the meeting of Committee D-11. Arrangements are being prepared in cooperation with the American Chemical Society's Division on Rubber Chemistry. It is expected that a meeting of I.S.O. Committee 45 on Rubber, of the International Organization for Standardization, will be held in Cleveland in connection with the D-11 meeting on October 9 and 10. This will be followed by an International Conference on Rubber sponsored by the A.C.S. Division at which some 16 technical papers from European technologists will be presented.

Also at the meeting work was initiated on a new project to test procedures for checking adhesion of bonded brake shoe and lining assemblies. This work is very timely in view of the very recent use of this method of applying brake linings in the manufacture of automobiles. The committee reviewed detailed descriptions of testing procedures now in use by a number of manufacturers; including Inland Manufacturing Division of General Motors Corp., Chevrolet Gear and Axle Division, Bendix Products, General Motors Research

Laboratories, Moraine Products Division of GMC, Chrysler Corp., and B. F. Goodrich Co. This new method of bonding brake linings increases greatly the life of the brake lining and also improves the effective braking area.

The relaxation characteristics of gaskets and packing materials received considerable attention. A survey of methods and apparatus in use has uncovered a number of devices as follows:

(1) Devices for recording relaxation continuously:
  (*a*) Beam machines of Blaw and Fletcher, Goodrich, and General Motors, (*b*) Baldwin Southwark hydraulic machine with strain holder, (*c*) Gehman air loader with automatic unloading, (*d*) The Farnam-Cole Relaxometer, (*e*) The Hypolog and modifications by New York Navy Yard and Government synthetic laboratory based on the SR-4 strain gage.
(2) Devices employing an aging jig which is tested for relaxation after an interval:
  (*a*) The Hopkins relaxation cell and modifications of the New York Navy Yard method, (*b*) The Mare Island Compressometer, (*c*) The Dresser Flush pen recorder, (*d*) Garlock Jig, (*e*) Navy Yard Seal Test.

The 1.129 by $\frac{1}{2}$-in. pellets of two 40 durometer GRS compounds which differ markedly in compression set at 194 F. have been distributed and an effort is being made to have these tested at 40 per cent deflection and at 158 F. and 212 F. Partial results to date indicate that all machines rank these relaxations in the same order as the compressometer although individual results vary widely. Full data will be reported in June.

A study is to be undertaken of a new method for compressibility and recovery of gasket materials. While the method was prepared primarily for automotive gaskets it can be used for other rubber products and will also be suitable for floor coverings such as linoleum, asphalt, and rubber tile, etc.

Work is to be started on test methods for crude natural rubber by a new subcommittee under the chairmansip of Norman Bekkedahl, of the National Bureau of Standards. The committee also plans to organize a new subcommittee on statistical quality control.

Changes are to be made in the methods of testing rubber hose (D 380 – 49 T). Provision will be made for a method for determining tube friction for woven wire reinforced type hose $\frac{3}{4}$ to 4 in. in diameter. A vacuum ball test for smaller sizes of hose is to be studied. The strength deterioration test of hose when the test liquid is a fuel is to be revised to provide for a test at 70 to 90 F. rather than 75 ± 5 F. Also when the test liquid is an oil the temperature will be 212 F. in place of 200 ± 2 F. This brings the test temperatures in line with other D-11 methods.

The subcommittee on rubber thread reported that it had received results from 8 out of 15 cooperating laboratories in a round-robin study of tests for specific gravity and modulus of rubber thread. This study was undertaken to evaluate procedures published as information last year. Some additional round-robin cooperative tests are planned.

Announcement was made at the meeting of the recent approval, as American Standards by the A.S.A., of four specifications for rubber protective equipment. These cover: Rubber Insulating Blankets (A.S.T.M. D 1048 – 49 T, A.S.A. J6.4-1950) Rubber Insulator Hoods (D 1049 – 49 T, J6.2-1950) Rubber Insulating Line Hose (D 1050 – 49 T, J6.1-1950), and Rubber Insulating Sleeves (D 1051 – 49 T, J6.5-1950).

The current specifications for rubber gloves (voltage rating of gloves, 3000 volts) (D 120 – 40) are being extensively revised and expanded. As a basis for the revision the committee is obtaining the views of many utility users.

The subcommittee on insulated wire and cable reported approval of revisions in its specifications and test methods. These will appear in the 1950 Report of Committee D-11. New work in progress covers the preparation of specifications and tests for cable shielding, jacketed and non-jacketed insulation, thin rubber insulation, Butyl rubber, and Polyethylene insulation.

An important accomplishment was the revision of the tension test of vulcanized rubber (D 412 – 49 T) which had been prepared in cooperation with representatives of industry and a number of Government agencies. The revised methods represent a considerable improvement in the technique for the tension test procedure which is one of the most widely used methods. Further study is to be made, particularly on increasing the speed of testing from the present rate of travel of the power actuated grip of 20 ± 1 in. per min. to 40 in. per minute.

The extensive methods covering procedures for the chemical analysis of rubber products (D 297 – 43 T) have been revised. The revision represents largely a rearrangement of the method but also includes certain changes to improve the analytical technique. These revised methods have been prepared in cooperation with the Federal Specifications Board.

Several new methods which employ optical, mechanical, and electronic devices in the testing of hard rubber are being studied in some 12 cooperating laboratories.

It was reported that the S.A.E.-A.S.T.M. Joint Committee on Automotive Rubber had completed new specifications which cover four different types of automotive mats with tensile strengths from 400 to 900 psi. New S.A.E.-A.S.T.M. specifications for rubber cups for high temperature and heavy-duty service have also been completed. These cover molded cups compounded from high-temperature resistant rubber for use in hydraulic actuated cylinders employing hydraulic brake fluid of a nonmineral oil type. The specifications are based on performance tests of the hydraulic brake cups under specified conditions and do not include requirements relating to chemical composition, tensile strength and elongation of the rubber compound. In addition revisions have also been completed in the existing tentative specifications for natural rubber cups for use in hydraulic actuating cylinders (D 818 – 45 T: S.A.E. R 60).

D-15 on Engine Antifreezes:
(Washington—Feb. 16)

Committee D-15 on Engine Antifreezes will present its first group of standardized test methods to the Society at the Annual Meeting on June 26. Action on these methods was taken by the committee at a meeting in Washington, on February 16 and 17, at which time progress was made on a number of other matters under study in the committee.

The details of the test method for freezing point have been given first consideration by the committee and have been under study by a group of cooperating laboratories. It was decided in Washington to await the outcome of some further collaborative work before submitting this method as tentative. The information and test data obtained in this study will be made available in the form of a technical paper. It is expected that the additional test work will be completed in June.

For use with the freezing point test, the committee has written complete specifications for a hydrometer-thermometer antifreeze field tester which outlines the minimum requirements for a

hydrometer-thermometer suitable for use at automobile service stations and other field testing places. It is intended for determining quickly the freezing protection provided by mixtures of water and the commonly used antifreeze products in automotive cooling systems or other suitable applications. The tester consists of a hydrometer float, float jar, suction bulb, thermometer, temperature correction chart or charts, a tester base having an intake tube, with the component parts assembled to provide a practical working instrument.

The committee is planning to make available information regarding the proper use of hydrometers. Instructions of this kind will undoubtedly be very appropriate for inclusion in a code of good practice which the committee has in preparation.

A complete test method for determining the equilibrium boiling of engine antifreezes miscible with water has been completed and will be issued as tentative this year. Another method to be issued as tentative covers the test for specific gravity of concentrated antifreezes at 60 F./60 F. by the hydrometer. It was also reported that active study is being made of a method for determining the specific gravity of dilute antifreeze solutions. Some seven different samples are being tested by a group of cooperating laboratories.

A method for determining water in engine antifreezes by the Karl Fisher method will also be issued as tentative. The data obtained by some six cooperating laboratories indicated that very satisfactory reproducibility is obtainable by the use of this test procedure.

The collaborative test study of the ash test procedure indicated there was no advantage in precision and reproducibility to be obtained from determining sulfated ash. The results indicated that a simple ashing procedure is adequate for antifreeze materials. The committee has accordingly decided to standardize the simpler, direct ashing procedure which will be issued as tentative.

The committee has also prepared a test for reserve alkalinity of engine antifreezes following the completion of a series of cooperative tests. It was decided that the cut-off point for the titration shall be at a pH value of 5.5. This method will be issued as tentative in June.

A new test for pH value of engine antifreeze will make use of the present A.S.T.M. Tentative Method for Determination of the pH of Aqueous Solutions with the Glass Electrode (E 70 – 46 T).

The Subcommittee on Simulated and Actual Service Testing has under way two cooperative test programs on corrosion and foaming, the static type beaker test is being used, and samples of antifreeze are being distributed to the cooperators. It was decided that each laboratory should use its standard test procedure regarding antifreeze concentration and conditions of operation. Correlation will be on the basis of rating the effectiveness of the antifreeze tested.

The simulated service corrosion test is based on the method used by the National Bureau of Standards. This method will be run by six collaborators under as nearly comparable conditions as possible.

D-16 on Aromatic Hydrocarbons:

Committee D-16 on Industrial Aromatic Hydrocarbons is giving consideration to enlarging its scope and field of activity to cover other products allied to those on which it has been working. The proposed enlargement of field of work to be covered by the committee would encompass such materials as pyridine, phenols, creosoles, anilines, heavy pharmaceuticals, etc.

The committee decided to refer to letter ballot vote a proposed revision of its standard method of test for distillation of industrial aromatic hydrocarbons (D 850 – 47) to provide for the use of the condenser from Method D 86 and also to provide that the particular thermometer to be used in the distillation test shall be covered in the material specification. These changes are in the interest of simplifying the method and bringing it into closer agreement with other A.S.T.M. distillation tests.

The committee also decided to request its Subcommittee on Specific Gravity to review the present tentative methods of test for specific gravity of industrial aromatic hydrocarbons (D 891 – 46 T). These methods now cover four procedures: (1) by specific gravity balance, (2) by hydrometer, (3) by pycnometer, and (4) by vacuum pycnometer. Some consideration will need to be given as to whether the individual material specifications should designate which of the four procedures are to be used. Also reference will be made in the revised method as to which procedure should be used as a referee test in case of dispute.

The committee is also cooperating with Committee D-2 on Petroleum Products and Lubricants in the development of a single copper strip corrosion test. It is considering the new D-2 method of test for free and corrosive sulfur in Petroleum Products (D 130 – 49 T) which includes the essential parts of method D 849 but describes the test in greater detail, including the use of a larger copper strip specimen, a different method of polishing, and a procedure for evaluating the copper strips at the end of the test.

D-19 on Industrial Water:

Preceded by a day and a half of subcommittee meetings, a very well-attended meeting of Committee D-19 on Industrial Water was held on March 3.

The Editorial Subcommittee reported that final drafts of chapters for the Manual on Industrial Waters are expected to be completed prior to the Annual Meeting and it is planned to present the manual to the Society for publication by the end of the year. Under methods of sampling, a recommendation was accepted for the continuation without revision of the Method of Sampling Boiler Water from Stationary Boilers (D 860 T). Four new methods of analysis were presented for adoption as tentative covering sodium and potassium, electrical conductivity, hardness (soap titration), and a method of identification of microorganisms. Recommendations were approved accepting the revision which has been prepared covering the Method of Test for Silica in Industrial Waters (D 859 T) and revision of the Recommended Practice for Application of X-ray Diffraction Methods to Water Formed Deposits (D 934 T). Other proposed methods of analysis which are being developed include copper, fluoride, matter extractable with chloroform, chlorine, turbidity, and color. New groups have been formed to study organic matter, bromide and iodide, schematic analysis of water, and hydrogen.

The Subcommittee on Classification recommended that all definitions appearing in existing Committee D-19 standards be grouped under a new A.S.T.M. designation. This will include additional definitions of electrical conductivity, hardness, and water-borne industrial waste. Rules for naming crystalline compounds will be added to Method of Reporting Results of Chemical Analysis of Water-Formed Deposits (D 933 T) and were recommended for immediate adoption. A significant recommendation by the Subcommittee on Methods of Testing was one covering specifications for substitute ocean water which will be published as information in an early issue of the ASTM Bulletin. A series of methods covering service testing was reported as being in process of formulation. Progress was reported on the preparation of specifications for Reagent Grade Water. The Subcommittee on Water-Borne Industrial Wastes reported progress in its four sections. Section A on Critical

Constituents has circulated for study a list of critical constituents in various industries. Section B on Analysis has organized ten subsections to develop methods on various items. Section C on Sampling has under development a proposed method for sampling of industrial waste water. Section D on Reporting Results of Analysis reported progress.

E-1. Subcommittees on General Methods of Testing

Meetings of subcommittees dealing with mechanical testing of materials were held; brief summaries of the matters considered at these meetings are outlined below.

Subcommittee on Tension Testing.—The work done since the last meeting by several task groups which have been working on different problems on tension testing of various materials was reviewed and discussed.

As a result of the reports of these groups, it is believed that several materials specifications can be coordinated in so far as their tension testing specifications are concerned, thus leading to simplification.

A draft of a proposed revision of the Standard Methods of Tension Testing of Metallic Materials (E 8 – 46) was reviewed at some length. Several further changes in the method are to be studied by the task group which prepared the revision and a revised draft of it, submitted for action at the next meeting of the subcommittee.

A report was received regarding a miniature test specimen, with a test diameter of 0.05 in., which probably will be adopted as a standard size, for use where insufficient material is available for the present standard size test specimens.

New methods for making tests to determine the tensile properties of very thin materials such as, for example, aluminum foil from 0.00017 to 0.0010 in. in thickness were discussed. A task group was appointed, including representatives from committees representing various materials, to study these methods for testing thin sheet materials of various kinds, and to present a report at the next meeting of this subcommittee.

Subcommittee on Hardness Testing.—Revisions in the A.S.T.M. Standard Method of Test for Brinell Hardness of Metallic Materials (E 10 – 27) were agreed upon. It is rather interesting to note that this standard method has been continued in use without change for the past 23 years. The changes have become necessary as the result of a wider application of the Brinell hardness method and the need for another test load. One of the most important changes was the decision to add Brinell hardness values for the 1500-kg. load. The present method now covers only the use of 500-kg. and 3000-kg. loads. The suggested hardness limits for the three series of test loads are as follows: (1) over 160 Brinell hardness number for 3000-kg. load, (2) between 159 and 80 BHN for the 1500-kg. load, and (3) under 79 BHN for the 500 kg. load. The revised methods will include the following hardness ranges for the several types of Brinell balls: (1) Steel ball not over 450 BHN, (2) Hultgren ball not over 500 BHN, and (3) Carbide ball not over 630 BHN. The tolerances on the Brinell ball are to be changed to read: "A ball suitable for use shall show a permanent change not greater than 0.01 mm. (0.0004 in.) when pressed with a force not greater than 3000 kg. against the test specimens."

Of particular significance was the decision at this meeting to undertake work on the following three new projects: (1) to prepare a new tentative method covering Diamond Pyramoidal Indentation Hardness tests, (2) to prepare rapid methods of ball indentation hardness, and (3) to study the minimum thickness of material to be tested by the Rockwell hardness machine. Task Groups were appointed to work on each of these problems.

Subcommittee on Speed of Testing.—The Subcommittee on Speed of Testing has been continuing its activity in advising other technical committees of the Society regarding the preferred methods of specifying speed of testing in A.S.T.M. standards. The two most widely used methods at present are the speed of head under load and the free running head speed. The latter is not recommended because it may differ too greatly from the actual head speed during test. At this meeting the committee considered the advantages of the elapsed time method of specifying speed of testing. This latter speed method is now being used in several Society standards. The advantages of this method will be called to the attention of interested A.S.T.M. committees. Action was taken to appoint a task group to prepare a revision of the present section on speed of testing in the general tension test methods for metals (E 8 – 46) to include methods involving the speed of crosshead under load and the elapsed-time method. It was reported that additions were in preparation to the extensive Bibliography on Speed of Testing which the committee published about two years ago.

Subcommittee on Calibration of Testing Machines and Apparatus.—The Subcommittee on Calibration of Testing Machines and Apparatus reported the completion of a method covering procedures for the verification and classification of extensometers. This method is applicable only to instruments that indicate or record values which are proportional to changes in length. Extensometers are classified on the basis of the magnitude of their errors. It is planned to include with this method the details of a procedure for calibrating SR-4 strain gages.

Action was taken to submit to letter ballot of the subcommittee a revision of the Tentative Methods of Verification of Testing Machines (E 4 – 47 T) and of Verification of Calibration Devices for Verifying Testing Machines (E 74 – 47 T). There was considerable discussion at the meeting regarding the inclusion of a note in Method E 4 suggesting that the calibration of a testing machine be conducted in a manner which simulates as nearly as possible the actual conditions under which the machine is used. This would mean that any mechanism which might affect the indication of the weighing system would need to be in operation if it is normally in operation during the use of the machine. Such mechanisms would include maximum pointers, autographic recorders, pendulum pawls, etc. There was considerable discussion of this proposal because of the considerable amount of time and expense that would be involved in calibrating a testing machine under all the various conditions under which it might be used. In view of the significance of this proposed change it was decided to circulate the proposal to the subcommittee members by letter and to have the comments received reviewed by a task group for further recommendation.

E-2 on Emission Spectroscopy:

(Pittsburgh—Feb. 16)

The Spring Meeting of A.S.T.M. Committee E-2 on Emission Spectroscopy was held at the William Penn Hotel in Pittsburgh on February 16, with the primary objective of furthering the work the committee is doing on suggested methods for emission spectroscopy. About thirty methods are now being given a final review by the committee before submittal to the Society for publication as information. It is probable that about twenty more methods will be ready before the end of this year.

Committee E-2 is also cooperating in the work on a "Suggested Nomenclature in Applied Spectroscopy" which is being prepared by the Joint Committee

on Nomenclature in Applied Spectroscopy (Joint Committee of Society for Applied Spectroscopy and A.S.T.M.). It is expected that the "Suggested Nomenclature" will also be submitted to the Society this year for publication as information.

E-4 on Metallography:

Although the year 1949 was one of the most productive from the Committee E-4 standpoint in view of finished work resulting (two new X-ray methods, one new method for dilatometric analysis, one new method for measuring grain size of wrought copper and copper-alloys, and revisions in two other metallographic procedures), the year 1950 also promises to be most productive.

A new method for classification of ferrite grain size in steel has been approved by the committee and will probably be approved for publication by the Society in 1950. In addition, a revision of the Recommended Practice for Thermal Analysis of Steel (E 14 – 33) is under way, including the latest practices in this field and particularly calling attention to the bibliography appended to the document as being very necessary for proper procedures. Much intensive work is being accomplished in preparing a list of definitions and nomenclature peculiar to the entire field of metallographic procedures.

The subcommittee on microhardness has been instrumental in the development of a very accurate stage micrometer by the Bausch & Lomb Optical Co. and is continuing its work on standardizing the various methods for measuring microhardness by circulating in the committee test blocks on which the various types of microhardness impressions are being made.

In 1949, a new subcommittee of Committee E-4 was established, Subcommittee XI on Electron Microstructure of Steel. This group, previous to affiliation with the A.S.T.M., had been carrying on its work for several years as the Joint Committee on Electron Microstructure of Steel. A test program on eutectoid steels has been completed, and it is expected to be printed as a part of the Committee E-4 Report for the 1950 Annual Meeting. This report on electron microscopy including approximately 44 micrographs is most interesting since its prime objective has been to attempt to project the results of light microscopy to the field of higher magnifications in the electron microscopy range. For the same steel specimens light micrographs at 1000 are compared to electron micrographs at 2500 and 15,000. Specimen preparation and etching procedure have been established so that electron micrographs at high magnifications are comparable to light micrographs.

Committee E-4 is planning to participate in the Photographic Exhibit at the 1950 A.S.T.M. Annual Meeting. Many unusual and interesting metallographic subjects will be included.

E-5 on Fire Tests of Materials and Construction:

Subcommittee meetings of Committee E-5 on Fire Tests of Materials and Construction were held on February 27 and 28 with the main meeting on March 1. In reporting on the activities of subcommittees the following items were noted. Changes in the tentative revision of the Standard Methods of Fire Tests of Building Construction and Materials (E 119) are being circulated for letter ballot. Tentative revisions covering the two methods for determining combustible properties of treated wood (E 69) and (E 160), were recommended for advancement to standard. Subcommittee IV appointed a special group to study test methods for determining the fire hazards of interior wall and ceiling finish materials after having defined the fire hazard characteristics which were deemed important. This group held two meetings in which numerous test methods were discussed and analyzed and came to the conclusion that the tunnel type of test now being used by the Underwriters' Laboratories was the only one which would provide the information considered essential for determining the fire hazard factors previously decided upon by the subcommittee. In addition, the special subgroup will study the tunnel test method with a view to simplifying this procedure and reducing its cost. A recommendation was made that measures be taken to secure necessary funds and personnel for this purpose. Action was also taken approving the reference to the ASA Sectional Committee A2 on all revised A.S.T.M. standards.

E-7 on Non-Destructive Testing:

To answer a very great need for radiographic standards for steel welds, Subcommittee II under the chairmanship of Alexander Gobus was organized in 1948 to establish a program for preparing suitable specimens and standard radiographic negatives. The entire program has now become a reality. Specimen blocks will be prepared by three cooperating companies including the Babcock and Wilcox Co., Combustion Engineering-Superheater Co., and the M. W. Kellogg Co. These blocks will become the permanent property of the A.S.T.M. Radiographic negatives of the blocks will be prepared through the entire range of standard X-ray equipment, including also Cobalt 60 radiation.

A method for magnetic particle testing of steel castings is being considered in Subcommittee III under the chairmanship of Hamilton Migel. The present A.S.T.M. document relating to this subject is the Tentative Method of Magnetic Particle Testing and Inspection of Commercial Steel Castings (A 272 – 44 T). Method A 272 included descriptions of the various procedures applicable to magnetic particle testing of steel castings. While this document has served a very useful purpose for a number of years, many people in the steel casting industry feel that a more definitive method can now be written in view of the wide experience with this non-destructive testing tool during the last war.

Committee E-7 will sponsor a papers session during the A.S.T.M. Annual Meeting in Atlantic City with the theme to be "The Rôle of Non-Destructive Testing in the Economics of Production." The papers will touch on both the engineering and managerial aspects of non-destructive testing with the following subjects proposed:

1. Principles and Mechanics of the More Important Non-Destructive Test Methods.
2. Typical Discontinuities and Their Metallurgical Origin.
3. The Economics of Casting Inspection.
4. The Economics of Weld Inspection.
5. The Economics of Wrought Products Inspection.

(Speakers will be recognized authorities in their particular fields.)

Committee E-7 is also planning to participate in the Photographic Exhibit to be held in conjunction with the Annual Meeting. Many interesting exhibits tying together the results of the various methods of non-destructive testing will be shown.

E-9 on Fatigue:

The chairman of Committee E-9 on Fatigue of Metals reported that after almost three years of preparation, the Manual on Fatigue Testing has now been published. This Manual, containing information on symbols and nomenclature, fatigue testing machines, preparation of specimens, test procedure, and similar information on fatigue testing of both ferrous and non-ferrous materials, represents a milestone in the activities of Committee E-9.

Professor H. F. Moore reported on the effect of speed of testing in fatigue tests. Mention was made that it is

highly desirable to make at least two tests at various speeds and that the speed of testing should be recorded. It was also pointed out that creep is a definite factor in high-temperature tests.

Subcommittee II is undertaking a major project in attempting (1) to prepare a list of all fatigue studies that are now in progress in this country, and (2) to list fatigue problems of a basic nature for which further information is desired. Although the original questionnaire to some 200 companies or organizations interested in fatigue was sent out since the first of the year, there have been more than 70 replies to date. Approximately one third of the replies indicate no current work is being undertaken, while the other two thirds report an average of two fatigue studies under investigation at the present time. It is planned to present a progress report of this subcommittee in the 1950 Report of Committee E-9.

Manual for Authors of ASTM Papers

EDITORIAL NOTE.—The article on "ASTM Papers—Their Preparation, Acceptance, and Publication" that appeared in the January issue of the Bulletin referred to the Manual for Authors of ASTM Papers that was then in preparation. This manual is published herewith. Comments and suggestions are solicited.

THIS Manual is intended to assist prospective authors in the organization and writing of technical papers which the Society can accept. The cost of publication permits the acceptance of only those papers having timely and significant information which is presented directly and understandably. Therefore the author of a technical paper must plan and prepare it with care if he expects to have it published by the Society.

The author largely controls the three stages in the evolution of a technical paper. These are its organization and preparation, its revision and editing, and its oral presentation. Although these three stages are closely interrelated, they form convenient divisions for the following discussion of the preparation of ASTM papers.

ORGANIZATION AND PREPARATION

A technical paper has four essential parts: a title, an introduction, a body of description and exposition, and a summary or conclusion. All are not of equal importance, but if any one is lacking or if the parts are not properly balanced, the effect of the paper on the reader is incomplete and may be entirely different from what the author intended. Therefore, the author must use care and thought to blend the parts into a unified paper which will convey his ideas to the reader with certainty. The following suggestions should assist the author in accomplishing this.

Title:

State distinctly the subject discussed.

Select a title which will permit proper cataloguing and indexing of the data.

Be brief but in attaining brevity do not imply greater scope than justified.

Introduction:

Discuss history or background (occasion for writing paper).

Describe briefly the major phases of the investigation, or parts of a review, in the order of subsequent discussion.

Body:

Divide into balanced parts, as indicated in the introduction and *in the same order.*

Order should be logical, but not necessarily chronological.

Tie the parts together with transitional sentences or paragraphs.

Use subheadings as necessary, but do not lean on them; the text should be understandable with headings removed.

Make clear what is shown by tables and illustrations; do not make the reader reason it out.

Always keep the subject in mind and avoid side excursions.

Avoid unnecessary backward and forward references.

Conclusion:

Repeat object of paper.

State clearly and briefly the significant new information brought out in the preceding discussion.

If results have brought the author to a decision say what this decision is and how it is justified.

If results indicate the need for further study indicate nature of additional work and whether author intends to undertake it.

REVISION AND EDITING

Good technical papers are not written, they are rewritten. After the author has prepared a first draft, he should lay it away for a few days while he regains an objective attitude toward his creation. Then he should undertake the revision. The revision can best be made in steps: consider first the unity of the whole paper, then the use of the data and illustrations, and finally the details of styling.

Unity:

Do title, introduction, and conclusions agree?

Is order of presentation in the body the same as forecast in the introduction?

Are the divisions in the body of the same relative importance?

Is the order used appropriate or should it be changed for understandability or emphasis?

(The first and last points are the most emphatic; intermediate points, less so.)

Are conclusions justified and explained in the body?

Data and Illustrations:

Present data concisely.

Use complete tables only when all values are needed for permanent reference. (See Appendix[1] for arrangement of tables or for minima required of abbreviated data.)

Present data graphically if possible. (See the Appendix for preparation of graphs.[1])

Use minimum sufficient drawings and photographs. Do not use construction drawings; prepare the drawings specifically for illustration. (See Appendix[1] for preparation of drawings and photographs.)

Include in the text a discussion of the significance of each table, graph, or illustration.

Styling:

Final styling is done by ASTM editorial staff.

Author's adjustment to ASTM style will save time and insure desired emphasis.

Provide adequate headings and subheadings. (At least one per printed column.) The headings should be ap-

[1] Appendix is not included.

propriate to the text.

See the Appendix[1] for preferred abbreviations and punctuation.

Prepare copies for Society in accordance with directions in Appendix.[1]

Prepare pre-presentation Synopsis. (See Appendix[1] for size and nature.) Condensation of the introduction and summary is usually appropriate for this synopsis.

Oral Presentation

After a paper has been submitted and accepted, the author must prepare to present it before a session of the Society. The text prepared so carefully for reading and study usually is unsuitable for oral presentation. Even if the paper is short enough to be read in the time allowed for presentation, its content may not be understood by an audience so that its significance may be lost. The oral presentation is the author's opportunity to summarize what he has done and to bring home personally to his hearers the importance of it. For this purpose a different text is needed. This text, its illustrations, and the presentation require a new preparation. The following suggestions may be of assistance in preparing the notes for this oral presentation.

Text:

Limit text to not more than 4 major points.

Use short sentences and short words. (See R. Flesch, "The Art of Plain Talk," Harper Brothers, 1946.)

Condense text for slow reading in allowed time (usually 10 to 20 minutes).

Provide clear summary and punch-line closing.

Illustrations:

Use the absolutely essential minimum number of illustrations. When one slide supplements another the two must be consecutive.

Try to group illustrations for consecutive showing at middle of presentation. The room should be lighted at start and finish.

Make each slide legible and include nothing that is superfluous. (See Appendix.[1])

Presentation:

Rehearse presentation with illustrations, if any. (The use of mirrors and a wire recorder in rehearsal aid effective presentation.)

Do not exceed time limit (usually 10 to 20 minutes).

Prepare to speak from limited notes, or memory. Do not read; speak directly to audience.

Discuss necessary arrangements with Session Chairman and lantern operator prior to Session.

Attention to these details and the manner of presentation of the paper in general will add greatly to the interest of the Session and to appreciation by the audience. A selected list of references amplifying these instructions is included in the Appendix.[1]

Patent Practice and Management for Inventors and Executives

Anyone who undertakes a book of the scope of this one is a courageous individual. As is to be expected, a book of this type, which endeavors to cover such subjects as patentability, infringement, patent prosecution, submission of ideas, licensing of patents, taxation, and foreign patents, cannot hope to present the many pitfalls which lie along an executive's path in charting a safe course in the management of any organization's patent program. Robert Calvert recognizes this in his preface, but it is believed appropriate to emphasize that the book should not be used as a substitute for competent legal advice. If this work is to be used as a means of obtaining a "speaking" knowledge of patent law to enable one to discuss problems with one's attorney, then it can be recommended.

The first portion of the book discusses things which are to be considered before filing an application for patent. Among the features of this portion is the very important one dealing with the question of inventorship. The explanation offered by the author should be helpful to one faced with the problem of who invented what.

As to that section of the book which deals with the preparation of a patent application, the author gives but one school of thought as to the best way of proceeding. It should be made clear that some attorneys have different views on this subject, and the reader should not forget this situation when discussing such matters with his patent adviser.

The discussion of the procedure after filing of an application is well presented, but the author does make a mistake, one which is made by many people, in referring to a suit in the United States District Court for the District of Columbia as an appeal from the Board of Appeals of the Patent Office. Such suits, commonly referred to as 4915 suits, are not appeals but are actions *de novo*.

The author's description of record-keeping and emphasis on its importance in establishing invention is very good and should be of particular interest to inventors.

As to the handling of secret information, sometimes referred to as submissions of ideas, it is believed that the author has made a good presentation which will give the executive some idea of the importance of formulating a definite policy dealing with the receipt of ideas submitted by people outside of his own organization. However, the author does indicate that the subject matter, if covered by a patent application, may be received without fear. Some people take the view that even this can be a risky procedure, as many applications never go to patent.

Patentability and infringement are presented briefly but, it is believed, with sufficient clarity to give the reader an idea as to what these things mean, thereby enabling the reader to distinguish between the two.

The very complicated field of taxes and of foreign patents is discussed briefly but in such a manner as to give the reader an idea as to what is involved in these phases of a patent program.

At the end of the book the author presents a glossary of terms generally used in discussing patent matters, and such a section will prove helpful to those who have occasion to discuss such matters. In addition to the glossary, certain forms appear which may be of interest to some readers.

The book contains a good index of authors and authorities cited as well as a rather comprehensive subject matter index. It contains a few illustrations of th. Patent Office which will give an idea of what the place looks like.

In conclusion, "Patent Practice and Management for Inventors and Executives" is a book which can be recommended to give those classes of people some idea of what patents are all about, but it is not one which will make a member of either of those classes an expert. If an inventor or executive buys the book, reads it, and is presented with a patent problem, he should consult his patent attorney.

The 371-page Patent Practice and Management for Inventors and Executives, by Robert Calvert is published by the Scarsdale Press, Box 536, Scarsdale, N. Y. (1950). The price is $5.

William L. Hughes

The American Society for *Testing Materials*

Every day at Headquarters we receive telephone queries from engineers, manufacturers, and consumers concerning the use of A.S.T.M. Standards. But the query which made us realize that the Society has truly become known universally ("for the promotion of knowledge of materials . . .") was the one from a soft-voiced housewife recently.

Over the phone she explained carefully that she had bought a white nylon blouse and intended to dye it black. But before experimenting she wanted to know if the blouse *could* be dyed and *what* dye to use.

Unfortunately, our Headquarters blouse experts were absent at the time and we had to refer her elsewhere.

PERSONALS • • •

News items concerning the activities of our members will be welcomed for inclusion in this column.

Note—These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.

Henry B. Allen, Executive Vice-President and Secretary of the Franklin Institute of the State of Pennsylvania, has been awarded an honorary degree of Doctor of Engineering by Drexel Institute of Technology, Philadelphia.

The American Society of Mechanical Engineers has honored twelve of its members by electing them to the grade of Fellows of the Society. Among those so honored are: **Howard Stewart Bean,** Chief of Capacity, Density and Flow-meter Section, National Bureau of Standards, Washington D. C., and since 1922 a leader in the development of orifice meters for measuring the rate of flow of both gases and liquids; **Ralph A. Sherman,** a member of the staff of Battelle Memorial Institute, Columbus, Ohio, since 1930, and more recently as Assistant Director of the Institute responsible for technical direction of all activities on fuels and mechanical equipment; and **Ludwig Skog,** Senior Partner, Sargent & Lundy, Chicago, Ill., one of the developers of the reheat cycle and cyclone furnace, and recipient of a Government citation for his work in power development and mechanical process engineering for the Oak Ridge (Tenn.) gaseous-diffusion plant.

Leonard C. Boller, formerly Chief Chemist, Technical Coatings, Inc., Pasadena, Calif., is now Vice-President and Chief Chemist, Coast Paint and Chemical Co., Los Angeles, Calif.

Frederic Bonnet, Director, Standards Dept., American Viscose Corp., Marcus Hook, Pa., has been elected a fellow of the Textile Research Institute. Joining American Viscose in 1925, after previous experience in the teaching and government research fields, and seven years of industrial research with Atlas Powder Co., Dr. Bonnet has made great and valuable contributions to textile technology. He has been active in the work of A.S.T.M. for many years, particularly its Committee D-13 on Textile Materials, serving presently as Vice-Chairman of that group, and a member of the Advisory Committee and numerous other subgroups.

Frank G. Breyer, member of the New York consulting metallurgical and chemical engineering firm of Singmaster & Breyer, has been made an honorary member of The American Institute of Chemists, in recognition of his important applications of chemistry and engineering in industry. Affiliated with A.S.T.M. since 1928, Mr. Breyer has been an active member of Committee D-1 on Paint for many years.

C. M. Butler has retired as Chemical Engineer, Marquette Cement Manufacturing Co., Oglesby, Ill., after more than thirty years of service with the company at the Oglesby plant.

LeRoy W. Clark, has retired as Head of the Department of Mechanics, Rensselaer Polytechnic Institute, Troy, N. Y., after more than forty years of teaching service at the institute. He is succeeded by Clayton O. Dohrenwend, who had been with the Midwest Research Institute since 1946, more recently as Assistant Director. Dr. Dohrenwend formerly served as an instructor at R.P.I. from 1931 to 1937.

John Howard Deppeler, formerly Consulting Engineer, New York City, is now Secretary, Boiler Code Committee, American Society of Mechanical Engineers.

M. L. Enger has retired as Dean of Engineering at the University of Illinois, and is now residing at 702 E. Fifth Ave., Escondido, Calif.

John H. Feigel, formerly Engineering Consultant in Buffalo, N. Y., is now Senior Building Construction Engineer, New York State Dept. of Public Works, Albany, N. Y.

J. H. Foote, formerly Supervising Engineer of Commonwealth and Southern Corp., Jackson, Mich., has been elected a Vice-President of its successor, Commonwealth Services, Inc., New York, N. Y., and President of the engineering subsidiary, Commonwealth Associates, Inc., with headquarters in Jackson. Mr. Foote has been with the Commonwealth and Southern and associated organizations since 1915, and in his new position will guide engineering policies in the change from a service company to an independent consulting company. One of the leaders in his field of work, Mr. Foote has participated intensively in the activities of various engineering groups including A.S.T.M. Twice he served on the A.S.T.M. Board of Directors, and at present is Chairman of Committee B-1 on Electrical Conductors, and serves on other technical groups.

Royal E. Fowle, for twenty years with the Granite Rock Co. of Watsonville, Calif., was appointed City Engineer of Watsonville, effective January 1, 1950. He is also superintendent of streets and sewers and manager of the water department.

Francis C. Frary, Director of Research, Aluminum Company of America, New Kensington, Pa., was awarded the James Douglas Metallurgical Medal for 1950 by the American Institute of Mining and Metallurgical Engineers, the citation reading "for distinguished achievement in science and contribution to society by broadening the field of knowledge in all phases of the aluminum industry and for his notable success in directing a vast research project in this industry." This medal has been awarded only four times in the past ten years.

Paul Giersing, formerly Production Mgr., Tunnel Portland Cement Co., Ltd., England, is now Civil Engineer, Cement-Jern Konsortiet, Denmark.

William C. Goggin, Manager, Plastics Technical Service, Dow Chemical Co., Midland, Mich., has been named a member of the Editorial Advisory Board of *India Rubber World.*

Theodore J. Gross is now Technical Adviser, Union Bag and Paper Corp., New York, N. Y.

L. Kermit Herndon, Professor of Chemical Engineering at Ohio State University, has been appointed Director of Research for Mathieson Chemical Corp., Baltimore, Md. He has been a Consulting Engineer to the company, and will continue to hold his university post while completing graduate research assignments and supervising Mathieson's Ohio State University Research Foundation project.

Alvin J. Herzig has recently been elected President of the Climax Molybdenum Co. of Michigan, the research subsidiary of Climax Molybdenum Co. Mr. Herzig joined Climax in 1931 as Chief Metallurgist.

Zay Jeffries, Vice-President of General Electric Co., in Charge of Chemical Dept., retired December 31, 1949. Vice-Chairman of the War Metallurgy Committee during the war, Dr. Jeffries had been a member of General Electric's four-man committee administering the Nucleonics Project, consisting of all work on atomic energy being conducted by the company for the Government. Affiliated with A.S.T.M. for almost thirty years, he was active through the years in many phases of the Society's work, being a member of the Cleveland District Council, and of several of the non-ferrous metals committees, also was a member of the Executive Committee 1930-1932.

At the Second Annual Honor Awards Program of the U. S. Department of Commerce in February several A.S.T.M. members and committee members were recognized: **Deane B. Judd,** Physicist, National Bureau of Standards, received an Exceptional Service Award; and **Donald B. Brooks,** Research and Development Board, National Military Establishment, and **Frank H. Jackson,** Principal Engineer of Tests, U. S. Bureau of Public Roads, received Meritorious Service Awards; Length of Service Awards also went to **Mr. Jackson** and **William Blum,** Chemist, National Bureau of Standards.

F. B. Lysle, member since 1915, retired December 31, 1949, from the Bureau of Lighting and Gas of the City of Philadelphia.

J. Strother Miller, formerly Technical Director of the Barber Asphalt Corp., and

now a consultant in asphalt technology, has joined forces with Warren B. Warden, under the name Miller-Warden Associates, as consultants in all phases of asphalt technology. Mr. Miller now resides and has his office at 63 Bernhardt Drive, Snyder, Buffalo, N. Y. The mailing address for Miller-Warden Associates is 731 Yale Ave., Swarthmore, Pa. A Past-President of the Association of Asphalt Paving Technologists, Mr. Miller is particularly well known in the petroleum and chemical fields after over forty years of service. Affiliated with A.S.T.M. since 1903, he was elected to Honorary Membership in 1946, and is presently Chairman of Committee D-8 on Bituminous Waterproofing and Roofing Materials.

Henry B. Oatley, Vice-President and Consulting Engineer, Combustion Engineering-Superheater Co., New York City, received the honorary degree of doctor of engineering from Stevens Institute of Technology in February. Dr. Oatley is Chairman of the Boiler Code Committee, is Vice-Chairman of Committee A-1 on Steel, and has been active in A.S.T.M. work and other engineering activities for many years.

Charles F. Pogacar, formerly Senior Fellow, Mellon Inst. of Industrial Research, is now Metallurgical Engineer, Koppers Co., Inc., Pittsburgh, Pa.

F. Warren Porter, formerly Paint Chemist, Color Craft Corp., Baltimore, Md., is now associated in a similar capacity with Maryland State Use Industries, Department of Correction, Jessups, Md.

Carlton H. Rose is now located in the Washington office of the National Lead Co., where in addition to other duties he will continue as Director of the Company's Specifications Department. Active for many years in various phases of A.S.T.M. work, Mr. Rose is the present Secretary of Committee D-1 on Paint.

R. A. Schatzel, Vice-President and Director of Engineering, Rome Cable Corp., Rome, N. Y., has been named a member of the Editorial Advisory Board of *India Rubber World*.

O. Harry Schrader, Jr., has been named the new Managing Director of the Douglas Fir Plywood Assn., the trade promotion organization of the 54-factory West Coast plywood industry.

T. D. Sedwick, formerly Engineer of Tests, The Chicago, Rock Island & Pacific Railway Co., Chicago, Ill., is now Manager, Specialties Dept., National Aluminate Corp. of the same city.

Herbert L. Sherman recently retired as Treasurer of Skinner & Sherman, Inc., Boston, Mass. Mr. Sherman has been affiliated with A.S.T.M. since 1904, and active in the New England District Council for several years.

Arthur L. Smith, formerly with the Harris Research Laboratories, Washington, D. C., is now associated with the Chatham Mfg. Co., Elkin, N. C.

Edward B. Snyder, formerly Technical Director, Kimble Glass Div. of Owens-Illinois Glass Co., Conshohocken, Pa., is now Plant Manager, Bentley Harris Mfg. Co., of the same city.

Raymond Szymanowitz, formerly Technical Director, is now Vice-President in Charge of Research, Acheson Colloids Corp., Newark, N. J.

John G. Thompson, Chief of the Metallurgy Division, National Bureau of Standards, Washington, received a Presidential appointment to serve on the 1950 Assay Commission which met in Philadelphia to test the weight and fineness of representative coins produced during the calendar year 1949 by the several mints of the United States.

Andrew Van Echo is now Asst. Wire Mill Superintendent, Joslyn Mfg. & Supply Co., Fort Wayne, Ind. He was previously Metallurgical Engineer, Wm. E. Pratt Mfg. Co., Joliet, Ill.

Mary E. Warga, Director of the Cooperative Spectroscopy Laboratory of the University of Pittsburgh, has been elected to the Board of Directors of the Optical Society of America.

Albert Weiner, formerly Engineer of Materials, U. S. Concrete and Soils Lab., Ithaca, N. Y., is now Concrete Technologist, U. S. Corps of Engineers, Department of the Army, New York City.

John M. Weiss, Consulting Chemical Engineer, New York City, served as moderator at the panel discussion on "Professional Licensing" held on the opening day of the recent Annual National Meeting of the American Institute of Chemical Engineers in Pittsburgh, Pa. The discussion included problems and special topics dealing with state licensing of engineers.

Thor H. Westby, Senior Engineer in charge of Sears, Roebuck and Co.'s Metallurgical Laboratory in Chicago, has retired in accordance with company policy. Among his technical accomplishments while at Sears were the development of a special metallic coating for wire; improvement of the chemical constituents in storage batteries with a new alloy which substantially increased the life of a battery; and the development of specifications for buying chromium-plated auto accessories. Mr. Westby had represented his company for several years on Committee A-5 on Corrosion of Iron and Steel.

New Members to March 22, 1950

The following 111 members were elected from February 3, 1950 to March 22, 1950, making the total membership 6691.

Names are arranged alaphabetically—company members first, then individuals.

Chicago District

ELGIN NATIONAL WATCH Co., T. L. Boswell, Research Engineer, Elgin, Ill.

BANERJEE, BANI R., Instructor, Illinois Institute of Technology, 3300 Federal St., Chicago 16, Ill. [J]*

BOLI, GEORGE T., President, Northern Malleable Iron Co., 867 Forest St., St. Paul 6, Minn.

CLOSE, CHARLES E., Secretary-Treasurer, Hardwood Plywood Inst., 600 S. Michigan Ave., Chicago, Ill.

ENTWISTLE, GEORGE, Chemist, Sinclair Refining Co., Control Lab., 400 E. Sibley Blvd., Harvey, Ill.

MELOCHE, VILLIERS W., Professor of Analytical Chemistry, Chemistry Dept., University of Wisconsin, Madison 5, Wis.

PETRY, STANTON H., Chief Engineer, W. M. Welch Manufacturing Co., 1515 N. Sedgwick St., Chicago, Ill. For mail: 2922 Payne St., Evanston, Ill.

ROUP, ROLLAND R., Chief Ceramic Engineer, Globe Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

SMITH, R. M., Vice-President, Union Tank Car Co., 228 N. La Salle St., Chicago 1, Ill.

SWANSON, HENRY T., Manager, C. & P. Lab., Radio Corporation of America, 3301 S. Adams, Marion, Ind.

Cleveland District

REPUBLIC STEEL CORP., Walter S. Scott Metallurgist, 1520 Republic Bldg., Cleveland 15, Ohio. [S]†

HOKENSON, LYNN N., Container Development Engineer, Ohio Boxboard Co., Rittman, Ohio.

NORRIS, WALTER L., Chief Engineer, The Gabriel Co., 14500 Darley Ave., Cleveland 10, Ohio.

ZWELLING, MARTIN, Chief Laboratory Engineer, Line Material Co., Box 510, Zanesville, Ohio.

Detroit District

BEAN, W. T., JR., Director, Industrial Electronics, Inc., 2457 Woodward Ave., Detroit, Mich. For mail: 19556 Bretton Dr., Detroit 23, Mich.

BITTNER, EDWARD FRANK, Chief Metallurgist, Detroit Gear Division Borg-Warner Corp., 12345 Kercheval Ave., Detroit, Mich. For mail: 5105 Grayton, Detroit 24, Mich.

ECKERT, OTTO E., General Manager, City of Lansing, Board of Water and Electric Light Commissioners, 116 W. Ottawa St., Lansing, Mich. For mail: Box 570, Lansing 3, Mich.

HEENAN, CLARK D., Partner, Pontiac Testing Laboratory, 1014 Baldwin Ave., Pontiac, Mich.

New England District

FRAM CORP., Paul Huber, Chief Research Engineer, 55 Pawtucket Ave., Providence 16, R. I.

FALL, WILFRED, Pullman-Standard Car Manufacturing Co., Worcester 6, Mass.

HASTINGS, CARLTON H., Physicist, Watertown Arsenal, Watertown, Mass.

LAMB, EDGAR L., Director of Research, Oxford Paper Co., Rumford, Me.

SHEEHAN, LEO JAMES, Textile Technologist, Boston Naval Shipyard, Boston 29, Mass. For mail: 173 High St., Reading, Mass.

STEARNS, S. RUSSELL, Assistant Professor of Civil Engineering, Thayer School of Engineering, Dartmouth College, Hanover, N. H.

TOWNE, S. H., Technical Manager, Bath Iron Works Corp., 700 Washington St., Bath, Me.

New York District

TALL OIL ASSN., Dernell Every, Secretary-Treasurer, 122 E. Forty-second St., New York 17, N. Y.

BAXTER, WILLIAM S., Secretary and Treasurer, J. H. Lane and Co., Inc., Box 82, Radio City Station, New York 19, N. Y.

LAUVER, MILTON R., Research Chemist, Westvaco Chemical Division, Food Machinery and Chemical Corp., 500 Roosevelt Ave., Carteret, N. J.

MCCONLOGUE, W. A., Assistant Manager, Industrial Sales Dept., Colgate-Palmolive-Peet Co., 105 Hudson St., Jersey City, N. J.

MORGAN, A. K., Chief Engineer and General Manager, Palisades Interstate Park Commission, Bear Mountain, N. Y.

MORSTAD, RALPH M., Plant Superintendent, Giessen Quartermaster Depot, U. S. Department of the Army, APO 169, c/o Postmaster, New York, N. Y.

PAKOFSKY, HERBERT, Chemical Engineer, 109 Parkville Ave., Brooklyn 30, N. Y. [J]

SCHWARTING, JOHN RUSSELL, Test Engineer, Grumman Aircraft Engineering Corp., Bethpage, N. Y. For mail: 214 W. Merrick Rd., Bellmore, N. Y.

SOUTHCOTT, ARNOLD M., Mechanical Engineer, Otis Elevator Co., 260 Eleventh Ave., New York 1, N. Y.

VILLA, FRANCIS F., Chemist, Cords Ltd., Division of Essex Wire Corp., 780 Frelinghuysen Ave., Newark 5, N. J.

WILSON, J. LYELL, Consulting Naval Architect, 145 Clifton St., Westfield, N. J.

ZIMMERMANN, ERICH K., Director, Service Labs., Titanium Pigment Corp., 99 Hudson St., New York 13, N. Y.

Northern California District

GOULD, JOHN J., Consulting Structural Engineer, 405 Montgomery St., San Francisco 4, Calif.

NEUMANN, M. R., Chief Engineer, Hersey Inspection Bureau, 3405 Piedmont Ave., Oakland 11, Calif.

Ohio Valley District

HOSIER, ALBERT E., Chief Chemist, The Faultless Rubber Co., Ashland, Ohio.

JACKSON, J. HARRY, Supervising Metallurgist, Battelle Memorial Inst., 505 King Ave., Columbus 1, Ohio.

KLOHR, GEORGE W., Metallurgist, E. I. du Pont de Nemours and Co., Inc., Box 993, Charleston 24, W. Va.

LEIGNER, FRANK, JR., Chemical Engineer, Stewart-Warner Corp., Southwind Div., 1514 Drover St., Indianapolis 7, Ind. [J]

PARKE, THOMAS V., Chemist, Eli Lilly and Co., 740 S. Alabama St., Indianapolis, Ind.

Philadelphia District

INTERNATIONAL RESISTANCE CO., S. J. Stein, Assistant Director of Research, 401 N. Broad St., Philadelphia, Pa.

SCHUTTE & KOERTING CO., Fred Boehm, Chief Engineer, Twelfth and Thompson Sts., Philadelphia 22, Pa.

BAUER, JACKSON, Chief Chemist, Fred Whitaker Co., Ridge Ave. and Scotts Lane, Philadelphia 29, Pa.

BLACK, WILLIAM F., JR., Technical Assistant, American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. For mail: 92 Elmwood Ave., Glenolden, Pa.

GRANDINETTI, JOHN R., Principal Design Engineer, City of Philadelphia, 1103 City Hall Annex, Philadelphia 7, Pa.

SCHWARTZ, JENNY, President, True-Test Laboratories, Inc., 20 S. Thirty-third St., Philadelphia 4, Pa.

SMITH, LEWIS' R., JR., Industrial Engineer, 119 E. Market St., York, Pa.

SPRY, FRANCIS D., General Manager, The Structural Slate Co., Pen Argyl, Pa.

Pittsburgh District

BODER, WILLIAM D., General Manager, Boder Scientific Co., 719–721 Liberty Ave., Pittsburgh 22, Pa.

DEITZ, WILLIAM ROBERT, Manager, Laboratory Services, The Neville Co., Neville Island, Pittsburgh 25, Pa.

POWELL, DAVID KENNETH, General Manager, Union Spring and Manufacturing Co., Eighth St., New Kensington, Pa. For mail: 656 Carl Ave., New Kensington, Pa.

STURROCK, M. G., Manager, Technical Section, Koppers Co., Inc., Tar Products Div., 1200 Koppers Bldg., Pittsburgh 19, Pa.

WERNER, ALFRED A., Fort Wayne Corrugated Paper Co., Box 113, McKees Rocks, Pa.

St. Louis District

DEHEKKER, LLOYD, Chemical Engineer, Rawlings Manufacturing Co., 2307 Lucas, St. Louis 3, Mo.

WILKE, J. MELVIN, General Manager of Sales, Laclede Steel Co., 1317 Arcade Bldg., St. Louis 1, Mo.

Southern California District

BARNES, HUGH, District Engineer, Portland Cement Assn., 816 W. Fifth St., Los Angeles 13, Calif.

BURGESS, RICHARD E., Director of Control, Don Baxter, Inc., 1015 Grandview Ave., Glendale 1, Calif.

DICKASON, JONMORE, Vice-President and General Manager, Metal Control Laboratories, 1220 Maple Ave., Los Angeles 15, Calif.

SHAW, L. A., Chief Chemist, Shell Oil Co., Box 728, Wilmington, Calif.

Washington (D. C.) District

COOK, GEORGE S., Paint Technologist, Engineer Research and Development Laboratory, Ft. Belvoir, Va. For Mail: 2869 S. Buchanan St., Arlington, Va.

DISTRICT OF COLUMBIA, DEPARTMENT OF INSPECTION, Robert H. Davis, Director of Inspection, Room 100, District Bldg., Fourteenth and E Sts., N. W., Washington, D. C.

FALLIN, EDGAR H., JR., National Petroleum Assn., 958 Munsey Bldg., Washington 4, D. C.

LIBBY, HAROLD C., Engineer of Bridges, Southern Railway Co., 713 W. Trade St., Charlotte 1, N. C.

SMITH, ARTHUR R., Chief, Construction Equipment Section, U. S. Department of the Army, Research and Development Div., Washington 25, D. C. For mail: 3601 Connecticut Ave., N. W., Washington 8, D. C.

Western New York-Ontario District

HICKS, T., John Inglis Co., Ltd., 14 Strachan Ave., Toronto 1, Ont., Canada.

KANE, JOHN J., Research Engineer, The Standard Stoker Co., Inc., 1701 Gaskell Ave., Erie, Pa.

MORREALL, HERBERT W., Department Manager, Ansco Div., General Aniline, Binghamton, N. Y.

U. S. and Possessions

AMERICAN CROSS-ARM, INC., P. N. Coleman, President, Box 1255, Jacksonville 1, Fla.

NATIONAL METAL AND SMELTING CO., C. A. C. Faiman, Jr., Chemist, Box 586, Fort Worth, Tex.

SOUTHERN SERVICES, INC., E. C. Gaston, Design Engineer, 600 N. Eighteenth St., Birmingham, Ala.

ALBERT, C. G., Technical Director, Edgar Brothers Co., McIntyre, Ga.

BOVAY, H. E., JR., Owner, H. E. Bovay, Jr., Consulting Engineers, Esperson Bldg., Houston 2, Tex.

DIETTERICH, CLARENCE W., Managing Director, Southern Plywood Manufacturers Assn., 728 W. Peachtree St., N. W., Atlanta, Ga.

HAYES, REUBEN, Engineer of Bridges, Southern Railway System, 101 N. Gay St., Knoxville 24, Tenn.

HITTLE, JEAN E., Materials Engineer, U. S. Bureau of Reclamation, Denver Federal Center, Denver, Colo.

HUGHES, BEN H., President, Hughes Brothers, Inc., Seward, Nebr.

LEWIS, CHARLES F., Metallurgical Engineer, Cook Heat Treating Co., 6233 Navigation Blvd., Houston 11, Tex.

LOUISIANA, STATE OF, DEPARTMENT OF PUBLIC WORKS, J. Lester White, Director, Eleventh Floor, State Capitol Bldg., Baton Rouge 4, La.

METCALFE, RICHARD LEWIS, Development Engineer, Carbide and Carbon Chemicals Div., Union Carbide and Carbon Corp., Texas City, Tex. For mail: 1017 Ross Ave., LaMarque, Tex.

PATTISON, BURT O., Owner, Pattison's Southwest Laboratories, Box 346, Harlingen, Tex.

PRIESTMAN, G. D., Manager, Supply and Transportation Dept., The Carter Oil Co., Box 120, Denver 1, Colo.

RADER, EARLE M., Consulting Engineer, Rader Knappen Tippetts Engineering Co., 1615 DuPont Bldg., Miami 32, Fla.

SCOTT, COURTNEY D., Materials Engineer, Box 434, Los Alamos, N. Mex.

SHIVERS, FRED A., Results Technician, Alabama Power Co., Gorgas Steam Plant, Gorgas, Ala. For mail: 1904 Euclid Ave., Jasper, Ala. [J]

WAGNER, WALTER K., Engineer, Albuquerque Gravel Products Co., Box 1352, Albuquerque, N. Mex. For mail: 1233 N. Vassar, Albuquerque, N. Mex.

WASHBURN, C., JR., Chief Engineer, Electric and Water Dept., City of Jacksonville, Utilities Bldg., Ft. Laura St., Jacksonville, Fla.

Other than U. S. Possessions

INSTITUTO DE INVESTIGACIONES CIENTIFICAS S. A., Faustino Prado Garcia, Chief Engineer, 7A Ave., No. 182, Miramar, Havana, Cuba.

SIEVERTS KABELVERK, Hans Olof Hansson, Chief Engineer, Sundbyberg, Sweden.

ARDELIUS, E., Production Engineer, A.-B. Scania-Vabis, Sodertalje, Sweden.

BARONA DE LA O, FEDERICO, Consultant on Cement and Concrete, Guanabana No. 68, Nueva Sta. Maria, Mexico 16, D. F., Mexico.

To the A.S.T.M. Committee on Membership

1916 Race St., Philadelphia 3, Pa.

Gentlemen:

Please send me information on membership in A.S.T.M. and include a membership application blank

Signed _____

Address _____

Date _____

BEAL, G. P., Director of Research and Development, International Waxes, Ltd., Agincourt, Ont., Canada.

BICKLEY, FRED EDWARD, Technician, Canadian General Electric Co., Ltd., 5781 Notre Dame St., E., Montreal, P. Q., Canada.

CAMPIONI, C. E., Standard-Vacuum Petroleum Mij., Soengei Gerong, Palembang, Sumatra, Indonesia.

EIDG. TECHNISCHE HOCHSCHULE BIBLIOTHEK, Leonhardstrasse 33, Zurich, Switzerland.

FOX, JOHN, Senior Partner, John Fox and Partners, Downbarton, Grand Ave., Hove 3, Sussex, England.

GIHBSSON, ROLF, JR., Purchasing Engineer, Nerliens kem-Tekn. A/S, Tollbodgt 32, Oslo, Norway. [J]

HARTE, MARGARET, Librarian, Monsanto Chemicals, Ltd., Ruabon, Wrexham, Denbighshire, England.

HITCHINS, S. A. B., Technical Superintendent, Turner & Newall (Canada), Ltd., 5600 Hochelaga St., Montreal, P. Q., Canada. For mail: Apt. 10, 5930 Cote des Neiges Rd., Montreal, P. Q., Canada.

INSTITUTE FOR INDUSTRIAL RESEARCH AND STANDARDS, Donald T. Flood, Research Director, Glasnevin House, Dublin, Ireland.

JOHNSON, TED, Chief Engineer and Assistant Manager, Sociedad Argentina de Ingenieros Proyectistas, Gutierrez 414, Mendoza, Argentina.

KAYSSER, FRIEDRICH, Head of Library, Metallgesellschaft A. G., Frankfurt a.M., Reuterweg 14, Germany.

MAGNEL, GUSTAVE, Professor, Laboratory of Reinforced Concrete, University of Gent, 90 boulevard Albert, Gent, Belgium.

RUSO, FELIPE B., Chief Engineer, Erection and Architectural Div., General Glass Equipment Co., Atlantic County Trust Bldg., Atlantic City, N. J. For mail: Edificio Beira Mar., Apt. 3, Avenida Beira Mar No. 454, Rio de Janeiro, Brazil.

SEALE, J. M. A., Technical Director, The Arborite Co., Ltd., 385 LaFleur Ave., Ville LaSalle, Montreal 32, P. Q., Canada.

VICTORIA, STATE ELECTRICITY COMMISSION OF, The Secretary, 22–32 William St., Melbourne, Victoria, Australia.

WILKINSON, J., The Yorkshire Copper Works, Ltd., Leeds, England.

ZOLDNERS, N. G., Concrete Engineer, Mount Royal Paving and Supplies, Ltd., 6301 Park Ave., Montreal, P. Q., Canada.

* [J] denotes Junior Member.
† [S] denotes Sustaining Member.

Society Appointments

Announcement is made of the following appointments:

A. L. PENNIMAN, Consolidated Gas, Electric Light and Power Co. of Baltimore, to replace ALEXANDER BAILEY, Commonwealth Edison Co., on the Joint Committee on Effect of Temperature on the Properties of Metals.

C. H. ROSE, National Lead Co., succeeding F. M. FARMER, as second representative on the ASA Standards Council.

A. E. MILLER, Sinclair Refining Co., to the Administrative Committee on Standards, succeeding J. L. MINER, deceased.

MYRON PARK DAVIS, Otis Elevator Co., for another term of two years on the ASA Safety Code Correlating Committee.

J. S. PETTIBONE of the A.S.T.M. Staff as alternate A.S.T.M. representative on the Inter-Society Corrosion Committee of N.A.C.E., succeeding C. S. COLE, deceased.

U. C. LAL and PETER DECICCO, Asheville-Schoonmaker Mica Co., Inc., as American representatives to the meeting of the ISO Technical Committee 56 on Mica held in Delhi on January 16.

F. E. VANDAVEER, The East Ohio Gas Co., to the American Assn. Gas Chemical Section, succeeding V. J. ALTIERI, deceased.

NECROLOGY

IRVIN S. BADGER, Eastern Representative, Metropolitan Paving Brick Co., Canton, Ohio; residence, 742 Ostrom Ave., Syracuse, N. Y. (March 4, 1950). Personal member since 1943 and representative of Paving Brick Institute (Washington, D. C.) membership since 1947. Representative of Paving Brick Institute (formerly National Paving Brick Assn.) on Committee C-15 on Manufactured Masonry Units, 1943–1949; on Committee D-4 on Road and Paving Materials since July, 1948; and on A.S.A. Sectional Committee A-37 on Road and Paving Materials since April, 1948.

CONYERS B. FINCKEL, Retired Textile Expert, J. H. Lane & Co., New York, N. Y.; residence, Montclair, N. J. (December 24, 1949). Representative of J. H. Lane & Co. membership from 1915 to 1927, and personal member from 1928 until his retirement in 1946. A long-time, active member of the Society, Mr. Finckel was one of the original thirteen members of Committee D-13 on Textile Materials, his affiliation with that group being continuous from its organization in 1915; he had been made an Honorary Member of the Textile Committee in 1947.

A. M. FULTON, Vice-President, Northern Malleable Iron Co., St. Paul, Minn. (February 15, 1950). Member since 1930, and member of Committee A-7 on Malleable-Iron Castings during his entire Society affiliation, serving on practically all of its subcommittees.

EMIL GATHMANN, President, Gathmann Engineering Co., Baltimore, Md. Member since 1914.

H. W. GILLETT, Chief Technical Adviser, Battelle Memorial Institute, Columbus, Ohio (March 3, 1950). (See article on adjacent page.)

F. A. HARTMAN, Vice-President, Protexol Corp., Kenilworth, N. J. (November 1, 1949). Representative of Protexol Corp. membership since 1943, and representative of the Corporation on Committee D-7 on Wood since 1943, and on Committee E-5 on Fire Tests of Materials and Construction since 1945.

W. W. KNIGHT, President, Roth Rubber Co., Cicero, Ill. (June 1, 1949). Representative of company membership since 1947.

GERALD T. KURTZ, Manager, Manufacturing Research, Research Div., The Paraffine Cos., Inc., Emeryville, Calif. (March 10, 1950). Representative of Paraffine Cos.' membership since 1948.

JOEL LAGERQVIST, Director, Chemical Laboratory, Sieverts Kabelverk, Sundbyberg, Sweden (August 16, 1949). Member since 1947.

P. W. LYON, Manager, Market Research, Wheeling Steel Corp., Wheeling, W. Va. Member since 1944.

RALPH W. MABE, Bridge Engineer, The Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn. (June 10, 1949). Member since 1944.

HARLEY A. NELSON, Assistant to General Manager, Technical Dept., New Jersey Zinc Co. (of Pa.), Palmerton, Pa. (March 21, 1950). Representative of his company on Committee D-1 on Paint since 1922, serving on the Advisory and many other subcommittees; also Special Adviser of Subcommittee on Conditioning

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To the A.S.T.M. Committee on Membership, 1916 Race St., Philadelphia 5, Pa.

Gentlemen:

Please send information on membership to the company or individual indicated below

_____

_____

This company (or individual) interested in the following subjects: (indicate field of activity, that is, petroleum, steel, non-ferrous, etc.,)

_____

Signed _____

Date _____ Address _____

and Weathering of Committee E-1 on Methods of Testing, and Consulting Member of Subcommittee on Accelerated Tests on Roofing Materials of Committee D-8 on Bituminous Waterproofing and Roofing Materials; also special representative of D-1 on other committees, and representative of A.S.T.M. on the Joint F.P.V.P.C.-A.S.T.M. Committee on Paint, Varnish, and Lacquer, serving for two years as Chairman of the last-named group.

WILLIAM B. PRICE, Director of Research (Retired), Scovill Manufacturing Co., Waterbury, Conn. (February 7, 1950). Member since 1913, Member of Executive Committee 1926–1928, and elected to Honorary Membership in the Society in 1948. Member for many years of Committees B-2 on Non-Ferrous Metals and Alloys, B-3 on Corrosion of Non-Ferrous Metals and Alloys, B-5 on Copper and Copper Alloys, B-8 on Electrodeposited Metallic Coatings, D-2 on Petroleum Products and Lubricants, E-2 on Emission Spectroscopy, and E-4 on Metallography.

MERLE RANDALL, Randall and Sons, Berkeley, Calif. (March 17, 1950). Member since 1944.

J. R. PUTNAM, Director of Engineering, United States Time Corp., Waterbury, Conn. Representative of company membership since 1942.

CHARLES E. SCHLEY, President, Philadelphia Bronze and Brass Corp., Philadelphia, Pa. (December 9, 1949). Member since 1924.

O. M. SETRUM, Phillips Petroleum Co., Bartlesville, Okla. Representative of his company since 1948 on Section on Classification and Nomenclature of Technical Committee on Tractor Fuels of Committee D-2 on Petroleum Products and Lubricants.

L. M. TOLMAN, Research Director, Wilson and Co., Inc., Chicago, Ill. (April 29, 1949). Member since 1936.

Horace W. Gillett

DR. H. W. GILLETT, 66, former director of Battelle Institute, died from a heart attack on March 3, 1950, near Nicholasville, Ky. One of the world's foremost metal scientists and a one-time associate of Thomas Edison, Dr. Gillett suffered the attack in a tourist camp while returning from a hunting trip in Florida and Georgia.

He was responsible for the technical organization of Battelle Institute and served as its first director from 1929 to 1934. He was the inventor of numerous metallurgical processes and author of scores of books and articles on scientific subjects. He was also the first editorial director of *Metals and Alloys* magazine. At the time of his death, Dr. Gillett was serving as a technical consultant to Battelle, having retired as chief technical adviser of the Institute in early 1949.

Dr. Gillett was a member of the American Institute of Mining and Metallurgical Engineers, the American Society for Metals, the American Society for Testing Materials, the American Foundrymen's Society, the Electrochemical Society, the British Iron and Steel Institute, the British Institute of Metals, the American Chemical Society, and Sigma Xi and Alpha Chi Sigma honor societies. Some of his professional honors included: AFA Medalist, Henry Marion Howe Memorial Lecturer (A.I.M.E.), and Fifth Edward Williams Lecturer (Institute of British Foundrymen).

In A.S.T.M. where he had held membership for over 25 years he served on several technical committees and contributed freely of his knowledge and experience. Probably his outstanding service to A.S.T.M. took the form of numerous technical papers, reports, and special bibliographies. The *Proceedings* and other technical publications of the Society incorporate many examples of his facility for contributing information in a unique and effective manner. He was called upon to edit or to prepare numerous special reports. In his death the Society loses a long-time member who did much to advance its work, to enhance the interest in the Society's publications and who leaves a host of friends.

Notes on Laboratory Supplies

Catalogs and Literature; Notes on New or Improved Apparatus

This information is based on literature and statements from apparatus manufacturers and laboratory supply houses.

Catalogs and Literature

The Baldwin Locomotive Works, Testing Equipment Department, Philadelphia 42, Pa. Bulletin 305 gives full details on the Baldwin-Tate-Emery PTE testing machine having ranges from 0–2 lb. full scale to 5000 lb. capacity. The bulletin illustrates the loading system internally as well as externally giving an explanation of operation, details on ranges, accuracy, new features, specifications, and accessories such as grips, strain followers, and recorders. Four pages, 8½ by 11 in.

Also, Bulletin 303, describes and illustrates new Baldwin portable hydraulic weighing system components for varied applications in industrial plants and testing laboratories. They include Emery hydraulic cells ranging in capacity from 1000 to 100,000 lb. capacity for compression and tension loads; and crane scales and portable cells with integral Emery bourdon-type indicators. Separate indicators of both bourdon type and highly sensitive and accurate Baldwin-Tate-Emery type are included. The bulletin also covers hydraulic lifting jacks and hand pumps for use with compression type load cells. 20 pages, 8½ by 11 in.

Boder Scientific Co., 719–721 Liberty Ave., Pittsburgh 22, Pa. A four-page folder (Catalog Section B-4912 describing Lindberg "H-F" combustion for the ignition of samples in carbon and sulfur determinations. The "H-F" unit comprises a short vertical glass combustion tube surrounded by an air-cooled coil to which high-frequency energy is supplied by a vacuum tube oscillator. The conventional boat is replaced by a high refractory "Cupelet" developed to withstand the thermal shock produced during the combustion cycle. Oxygen is introduced through integral piping. The use of rubber tubing has been eliminated and flow is regulated by control valves situated on the front panel. The Unit is designed for granular samples, or for borings and turnings normally employed in carbon and sulfur determinations. However, solid samples have been successfully fused, and satisfactory determinations have been performed on total carbon of cast irons as well as various alloy steels.

The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill. Bulletin 165-50, Precision Spectrometer L124, describes and illustrates a new model divided circle spectrometer reading to 1 second of arc. The instrument is used principally for precise determinations of refractive indices and dispersion, and for measurement of prism and wedge angles. A camera attachment, polarizing attachment, Babinet soleil compensator, and infrared attachment are offered as accessories. Four pages.

Also, Bulletin 181-49, Coordinate Comparator M1225-37, describes and illustrates a comparator intended for measuring star photographs, spectrograms, X-ray plates, charged particle tracks, and any similar records made on 3¼ by 4¼-in. photographic plates. Measurements are made with a moderate power microscope mounted in a micrometer slide having a range of 100 mm. and reading to 0.01 mm. Transverse motion of stage by rack and pinion can be read to 0.05 mm. and 360 rotations of the stage provide means for measuring with micrometer slide along any axis, as in polar coordinates. Two pages.

Also, Gaertner's Bulletin 174-50 describes and illustrates the Precision Optical Bench Assembly—a lens testing bench. The assembly consists of a collimating system with light source, targets and filters, a nodal slide, and a viewing microscope, all mounted on a lathe bed-type bench. Each component is described in detail. A foucault knife-edge attachment, available as an accessory, is also described. Four pages, 8½ by 11 in.

The Emil Greiner Co., 20–26 N. Moore St., New York 13, N. Y. A four-page folder entitled "New and Better Laboratory Equipment with Trigger Thermo Control" describes and illustrates electric utility laboratory ovens, including OV-12, OV-8, and OV-18.

E. Machlett & Son, 220 East 23rd St., New York 10, N. Y. This 80-page cata-

logue entitled "Machlett Laboratory Chemicals and Reagents" includes a representative listing of chemicals, reagents, biological stains and solutions as well as other preparations in general demand. The contents include data on Laboratory Chemicals, Volumetric Solutions, Buffer Solutions, Indicator Solutions, Crystalline pH Indicators, Staining Solutions, Copper Sulfate Standards, Biological Stains, Preparations for Clinical Procedures, pH Test Papers, Pfanstiehl Rare Sugars and Amino Acids, and Difco Dehydrated Culture Media. Illustrated, 8½ by 11 in.

E. H. Sargent & Co., 4647 W. Foster Ave., Chicago 30, Ill. "Scientific Apparatus and Methods" (Including Latest Catalog Revisions)—Vol. 3 (Winter), 1949–1950—includes in its Section I on Scientific Methods articles on "The Polarography of Tin," "High-Frequency Chemical Analysis," and a picture story of Sargent's new plant. Section II, Scientific Apparatus, cover new, reinstated and discontinued items, and changes in specifications.

The Superior Electric Co., Bristol, Conn. A twelve-page bulletin, No. 749, "Powerstat Light Dimming Equipment," 8½ by 11-in. size. The bulletin is complete with photographs, circuit diagrams, outline dimensions and descriptive material, and displays Powerstat Dimmers from the small, 1000-watt manually operated single unit through the heavy-duty motor-driven unit with an output up to 30,000 watts. The bulletin opens with a discussion on the creation of "atmosphere" through the dimming, brightening, and blending of light. There is included a chart giving Powerstat Dimmer electrical ratings, approximate dimensions, and weights and other information.

Instrument Notes

New Coating-Thickness Gage—American Instrument Co., Inc., Silver Spring, Md. A new special-purpose Magne-Gage for measuring the thickness of nickel coatings on iron or steel in the range of 0.001 to 0.0045 in., by magnetic means, without injuring the coating or base metal, is announced. This thickness range is beyond that of the standard Magne-Gage (which measures thickness of nickel coatings on iron or steel from 0 to 0.002 in.) and cannot be supplied on Magne-Gages having other calibrations.

Humidity-Temperature Test Apparatus with Program Control—American Instrument Co., Inc. Precisely controlled variations of humidity and temperature can be repeated periodically by means of a new versatile test apparatus recently announced. Standard apparatus provides three humidity-temperature program schedules. The apparatus consists of a test chamber, an airconditioning unit, and a special control system.

Titration pH Test Unit—Central Scientific Co., 1700 Irving Park Road, Chicago 13, Ill. This Unit is for fast titration, control of neutralizations, oxidation-reduction reactions and precipitations, and pH measurements. It is used for the determination of manganese in iron and steel, electrometric measurement of pH values of aqueous or partly nonaqueous solutions, tests for acid and base numbers of petroleum products; sampling and chemical analysis of inorganic alkaline detergents, tests for dissolved oxygen in industrial waters, and the saponification number of petroleum products. It is also suggested for use in ferrous analyses, and for the determination of arsenic, chromium, copper, manganese, nickel, nitrogen, phosphorus, selenium, sulfur, tin, and vanadium.

Instru-Mount—a Vibration Damping Instrument Mount—Eberbach & Son Co., Ann Arbor, Mich. This is a vibration damping, nonmagnetic base upon which the user can mount delicate mechanical, optical, or electrical instruments. It is stated that the Instru-Mount protects them from vibrations with frequencies as low as 10 cycles per second.

Hunter Goniophotometer—Henry A. Gardner Laboratory, Inc., 4723 Elm St., Bethesda 14, Md. This instrument is used to measure the manner in which flat specimens reflect and transmit light with changing directions of illumination and view. It consists of a stationary photocell which receives light (through a colored filter if desired), a specimen table which may be rotated to place the specimen in any desired attitude with respect to the photocell, and an illuminating arm with light source for directing a beam of light onto the specimen from any desired direction. In the field of light transmission, the apparatus may be used for detailed measurement of turbidity, translucence, and the haze of specimens due to light scattering.

New Design of Powerstat Variable Transformer Type 116 and 216—The Superior Electric Co., Bristol, Conn. The new design is not a "face-lifting" operation, although a streamlined appearance has resulted. All improvements have been made within the old standard mounting dimensions to conform to existing panel layouts. Ratings of Types 116 and 216 remain the same. Type 116 operates from a 115-volt, 50/60-cycle source to deliver 0–135 volts, 7.5 amperes output. Type 216 has an output of 0–270 volts, 3.0 amperes from 230 volts, 50/60 cycles, 1 phase. The new design incorporates features which make the entire unit more rugged, protecting it against the abuses of constant use and rough shipping treatment.

The Varicell—The Superior Electric Co. This provides a stabilized and regulated source of variable d.-c. voltage from a.-c. power lines. It operates from a 95 to 135-volt, 60-cycle, single-phase alternating-current line; delivers a direct-current output that is variable from 0 to 30 volts. The allowable output current available at any voltage setting is 15 amperes. The unit was developed to meet the demand for a single piece of equipment that would provide stabilized and regulated variable d.-c. voltage from a.-c. power lines.

Mercury Thermal System for High-Temperature Applications—Taylor Instrument Cos., Rochester 1, N. Y. This new Mercury Thermal System provides simple, dependable, and less expensive means of measurement and control of temperatures above the conventional 1000 F. indication. Such applications as gas-fired ovens, annealing ovens, high-temperature blanchers, measurement of exhaust gases, and others can be accurately served with this new measuring system. Outstanding features include a newly developed Bourdon Type Spring, Type 347 stainless steel thermal element, compensation for varying case and ambient temperatures, and uniformly graduated charts.

Strain Indicator—The Baldwin Locomotive Works, Philadelphia 42, Pa. A new Type "L" portable, battery-powered strain indicator for use with SR-4 bonded resistance wire strain gages is a refinement of Baldwin's Type "K" instrument with several new features. Four improvements have been made in this direct reading instrument. First, the ten "thousands" steps are increased from 1000 to 2000 microinches per in. per step, giving a total of 20,000 microinches per in. Second, the range extender has been increased from an approximate 10,000 microinches to a more exact 20,000 microinches with an accuracy within ±50 microinches. This change extends the balancing range of the instrument to ±30,000 microinches, which is broad enough to cover all practical applications of SR-4 strain gages. Third, the new model can be used with a Wheatstone bridge circuit without modifying the internal circuit. The fourth change is provision of an oscilloscope connector jack for applications in rephasing problems sometimes encountered when using extremely long leads between SR-4 strain gages and the instrument. The instrument is designed and calibrated for 120-ohm gages with gage factors of 1.77 to 2.20.

Amsler High Frequency Vibrophore—Adolph I. Buehler, 228 N. La Salle St., Chicago 1, Ill. This Vibrophore serves for determining the resistance to repeated tension, compression, alternate tension or compression, shearing, transverse and torsion stresses of material such as steel, light metal, plastics, ceramics, etc., or for determining the effect of dynamic forces on structural elements such as riveted or welded joints, threaded sections, wires for ropes and pre-stressed concrete, as well as for the quantitative determination of the damping capacity of materials. The addition of an electric furnace or cold chamber enables tensile and compression tests at elevated or subnormal temperatures to be made. The machine operates on the resonance principle, the number of cycles coinciding always with the natural frequency of the vibrating elements. The magnitude of the natural frequency depends on the size and elasticity of the specimen and on the weight of the oscillating masses and can be changed conveniently within wide limits by adding or removing weight disks, thus altering the main mass. The operator, however, is not bound to adhere to one definite size of specimen. The force in action is measured by an optical dynamometer. The calibration of the machine remains constant, but can be checked at any time desired, in a simple manner.

Dyna-Cath—Eberbach and Sons Co., Ann Arbor, Mich. This instrument is useful for determining aluminum in steel and in zinc-base alloys; zirconium in iron and steel; and uranium, alkaline earths, and alkali metals in alloys of iron, copper, nickel, chromium, zinc, molybdenum, and other metals. It employs the mercury-cathode principle for separating interfering metals. Its magnetic circuit causes rapid countercurrent stirring at the mercury-electrolyte interface, continuous cleaning of the mercury surface, and minimum resolution of the deposited metals.

Equipment for the Determination of Insulation Resistance at High Relative Humidities

By A. T. Chapman[1]

THE importance of testing the electrical resistance of materials under controlled temperature and humidity conditions has been long recognized and covered by A.S.T.M. specifications and methods.[2] While the basic method for making such tests on a laboratory basis in limited volume is reasonably satisfactory, a need has existed for better methods and facilities for production testing.

Controlled humidity has been generally obtained by means of solutions of glycerin, salts, or sulfuric acid.[3] Such solutions are troublesome to adjust, maintain, and handle. They tend to creep, corrode the test equipment, may contaminate the samples, and unless used under carefully controlled conditions may give undetected, large errors in humidity. A straightforward electromechanical means of obtaining, controlling, and recording the humidity is desirable for routine testing.

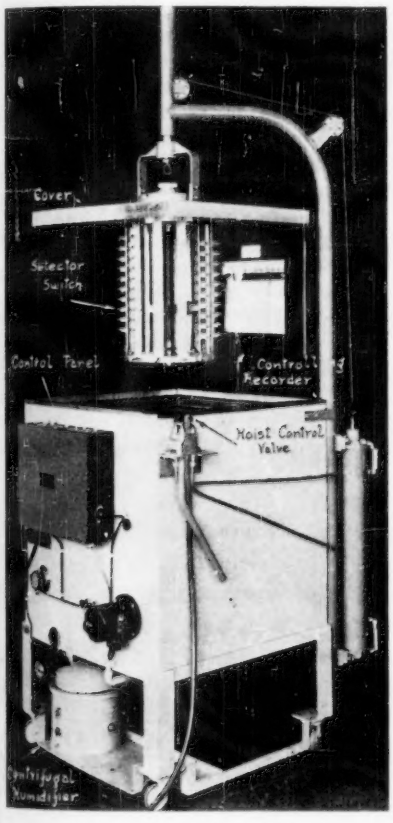

Fig. 1.—Humidity Cabinet.

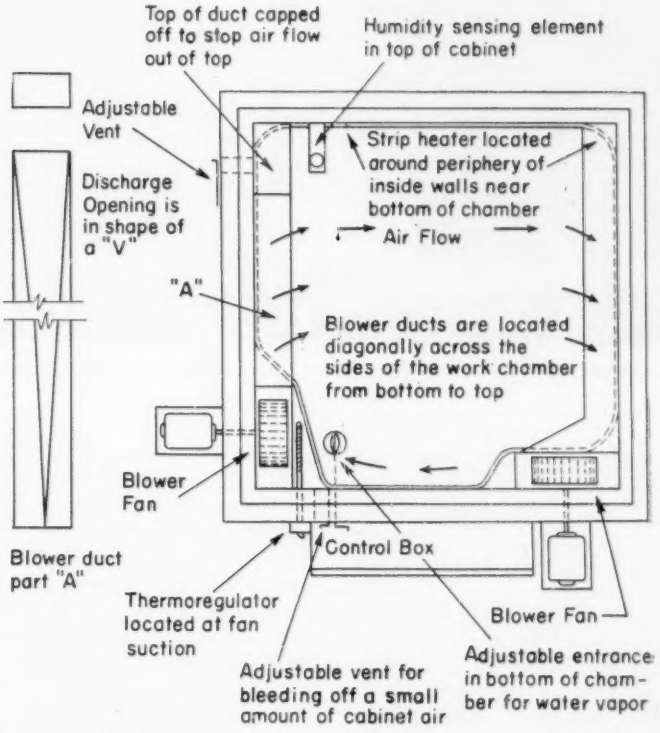
Top of duct capped off to stop air flow out of top
Humidity sensing element in top of cabinet
Adjustable Vent
Discharge Opening is in shape of a "V"
Strip heater located around periphery of inside walls near bottom of chamber
Air Flow
"A"
Blower ducts are located diagonally across the sides of the work chamber from bottom to top
Blower Fan
Blower duct part "A"
Control Box
Thermoregulator located at fan suction
Blower Fan
Adjustable vent for bleeding off a small amount of cabinet air
Adjustable entrance in bottom of chamber for water vapor

Fig. 2.—View Looking Down into the Work Chamber with Cover Removed.

Even though a statistical sampling scheme is employed, production testing requires equipment capable of handling a large number of samples. This gives rise to the problem of making connections two at a time from a large number of terminals inside the humidity cabinet to two terminals of a test set outside the cabinet. The arrangement of a large number of lead wires within the cabinet offers mechanical design problems to minimize load and unload time. The necessity of bringing a large number of highly insulated leads through the cabinet wall complicates the provision of an adequate guard circuit which is required to overcome electrical leakage.

Recently it became necessary to provide new equipment in the Materials Testing Laboratory at the Western Electric Co., Kearny Works, to replace test chambers which had become, over a period of years, badly corroded and contaminated with the solutions used for controlling humidity. It was felt that the cost of operation and maintenance and the uncertain results obtained with the commonly used type of equipment justified a new approach to design.

Apparatus

Humidity Cabinet:

The Standard American Instrument Co. No. 5-3720 precision-controlled humidity cabinet was selected as having the desired physical qualifications. The cabinet, which is shown in Fig. 1, has outside dimensions of 36 in. high by 35 in. wide by 34 in. deep and inside dimensions of 24 by 24 by 24 in. In order to ensure the desired precision of better than 0.5 per cent relative humidity, a Walton Laboratories Model N centrifugal humidifier replaced the standard steam generator.

The humidifier consists of a water reservoir, an atomizing head, and a vapor distributing dome. A constant level of distilled water in the reservoir is maintained by a float valve. The atomizing head is an assembly of a verti-

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[1] Engineer, Western Electric Co., Kearny Works, Kearny, N. J.

[2] Standard Methods of Test for Insulation Resistance of Electrical Insulating Materials (D 257–46) and Tentative Methods of Conditioning Plastics and Electrical Insulating Materials for Testing (D 618 – 47 T). 1949 Book of A.S.T.M. Standards, Part 6, p. 465.

[3] Tentative Recommended Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions (D 1041 – 49 T), 1949 Book of A.S.T.M. Standards, Part 6, p. 768.

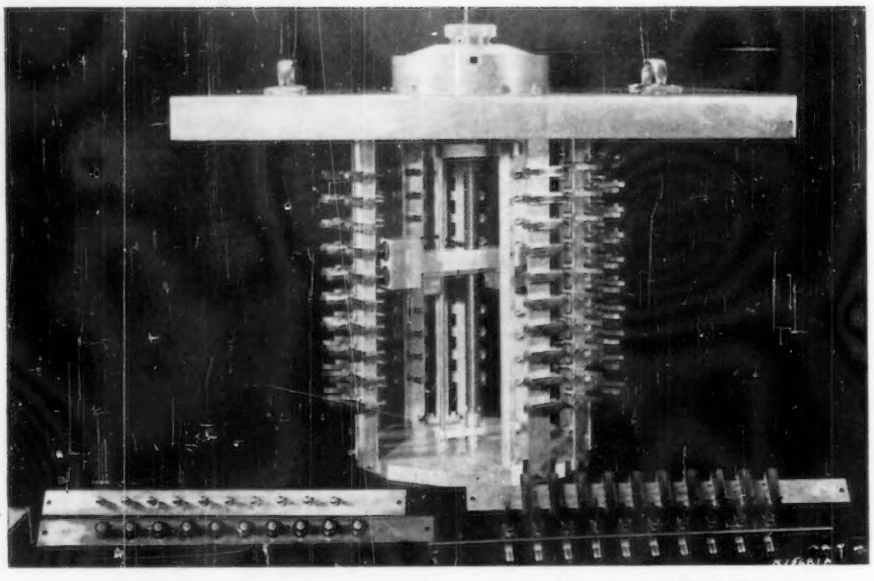

Fig. 3.—Switch and General Use Fixtures for Testing per A.S.T.M. D-257.

cal shaft motor with hollow tube shaft extension having an impeller cap covering the open end. For normal operation, the impeller cap is approximately one inch below the level of water in the reservoir.

Rotation causes the cap to lift water through the hollow tube to an elevation opposite the top surface of a flat disk which is spinning on the motor shaft. Water passes through the tube wall to the top surface of the disk and centrifugal action throws water from the periphery of the disk through a stationary comb which surrounds the disk.

Impact causes atomization and a fan under the disks draws air through the unit to create a slight pressure inside of the vapor distributing dome. This pressure then introduces atomized water into the cabinet through a short duct which is controlled by a butterfly valve.

As shown in Fig. 2, the air circulation is maintained across the working space of the cabinet by two ducts, one on the right and one on the left inside wall, each equipped with a small blower type circulating fan which serves to distribute the humidified air throughout the cabinet. Two small adjustable ventilators, one on the front and one on the left side, are provided to relieve the slight air pressure developed by the humidifier. The resultant flow of air, although very small is essential to keep the temperature and humidity controls operating in short-time intervals which in turn is necessary to assure precise humidity control. Humidity is controlled by an Aminco Type H-2 humidity sensing element located in the upper rear of the cabinet. The sensing element starts and stops the operation of the humidifier through the Brown type No. 4-3866 Controller Recorder which also provides a continuous record of the humidity.

Temperature is controlled by an Aminco bimetal thermo-regulator which operates an enclosed 350-w. heater located around the periphery of the inside walls. No refrigeration is provided because all tests currently specified are well above ambient temperature.

Fixtures:

Two types of general use fixtures which conform to A.S.T.M. Method D 257[2] are shown separately and mounted on the selector switch in Fig. 3. The fixtures are made from $1\frac{1}{4}$ by $17\frac{1}{2}$-in. aluminum channels. Specimens are mounted on one type with nuts and washers and on the other type with readily detachable phosphor bronze spring clips. Electrical grade polystyrene is used for the insulating details. Spare strips are available for loading new specimens. The fixtures are designed to be quickly and easily mounted and removed from the switch frame by slots and wing nuts.

Selector Switch:

In order to mount the test fixtures and make connections to each test position rapidly, a selector switch shown fastened on the cabinet cover in Fig. 3 was designed. The switch comprises two dodecagonal plates $11\frac{1}{2}$ in. wide separated by four supports. Twelve fixtures which hold the test specimens are mounted vertically on these plates. A screw with a $1\frac{1}{4}$-in. pitch runs through the center of the plates and carries the contactor arm. This arm is rotated by two tie rods, and the whole mechanism is actuated by a dial externally mounted on the cabinet cover. As the dial is rotated, the two contact points describe a helical path and successively make contact with the 108 pairs of test terminals. An index on the dial shows not only which strip but also which position on the strip is under test to avoid any errors in the recording of data.

Electrical connections are made to the two springs on the contactor arm through the tie rods which are insulated from the remainder of the assembly by polystyrene bushings. Springs on top of the tie rods connect with two slip rings which in turn are connected to a coaxial jack located to the rear of the dial on the cabinet cover.

The switch and sample holders are designed so that the test leads are completely shielded by a guard circuit to

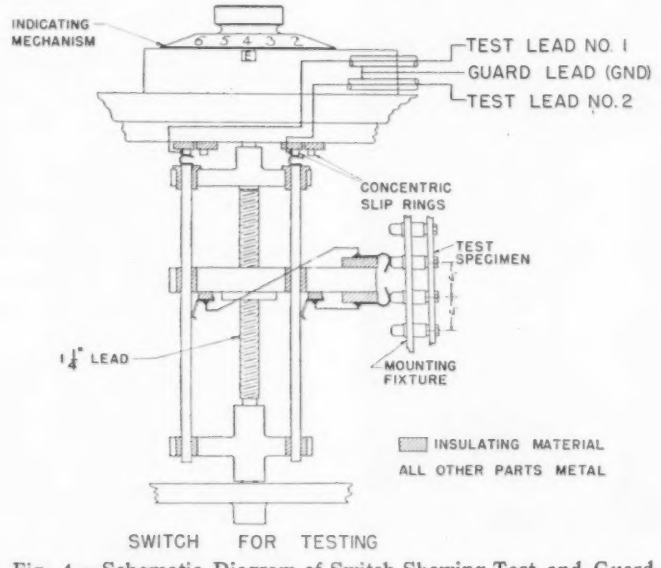

Fig. 4.—Schematic Diagram of Switch Showing Test and Guard Circuits.

minimize extraneous leakage currents. In this switch, when exposed to 90 per cent relative humidity, the leakage resistance between the two test leads is greater than 400,000 megohms and between either test lead and the guard circuit is in the order of 30,000 megohms. All details of the switch except the spring contacts, tie rods, slip rings, and jack terminals are grounded and connected to the guard circuit. The two slip rings are mounted on the grounded cover by polystyrene stand-off insulators. The importance of the guard circuit is emphasized in A.S.T.M. Method D 257.[2] Figure 4 schematically shows the switch with test and guard circuits.

Shielded coaxial cable is used to connect the jack to the test instrument which for routine tests is a Freed Megohmmeter Type 1020. For referee tests, particularly at very high insulation-resistance values, the balanced galvanometer circuit using a standard resistance shown in Fig. 7 of A.S.T.M. Method D 257[2] is used.

To facilitate loading and unloading the fixtures from the switch, a pneumatically operated hoist is provided which is controlled by a two-way air valve located at the upper right-hand side of the cabinet. In the raised position it is possible to rotate the cover and switch to four positions maintained by a ball catch. In the lowered position, slack in the cable permits releasing the weight of the fully loaded switch which aids in keeping the cover well seated during test operations, a necessary precaution in maintaining close humidity control.

The use of the foregoing switch eliminates the need for preparing a large number of electrical connections between the test strips and a terminal panel built into the side of the cabinet which was the previous practice. Likewise, it substantially reduces the time required to make external connections to the test set.

Procedure

To determine the capability of the foregoing equipment, tests were made on the cabinet with switch both inside and outside an air-conditioned room.

Humidity was determined in six positions in the cabinet by slowly withdrawing 9 liters of air through a weighed drying tube and computing humidity from the gain in weight. A parallel check was made by moving a spare calibrated Aminco sensing element to the same location from where the air was being withdrawn. Temperature was measured by calibrated copper-constantin thermocouples located in the six positions. While the cabinet was located in an air-conditioned room held at 72 ± 2 F. and 45 ± 2 per cent relative humidity, the cabinet conditions were maintained throughout all six positions to 90 ± 0.2 per cent relative humidity at 87.0 ± 0.1 F. While located in a non-air-conditioned room with temperatures varying from 75 ± 5 F. and humidity, from 50 ± 10 per cent relative humidity, the cabinet maintained 90 ± 0.5 per cent relative humidity at 87.0 ± 0.2 F. There is an ample margin between cabinet performance and the A.S.T.M. referee limits of 90 ± 1 per cent relative humidity and 95 ± 2 F.

Ease of bringing the cabinet to the desired humidity conditions is worthy of note. Starting from ambient conditions, on the average, ten to fifteen minutes are required before the 90 per cent relative humidity 87 F. conditions are attained. After unloading and reloading, these conditions are achieved in six minutes. A spare cover is placed on the cabinet during the loading operation.

Another condition which has been attained with the same rapidity is 95 ± 0.5 per cent relative humidity and 104 ± 0.2 F. In the latter case, however, auxiliary heating has to be provided to the humidifier to prevent the water spray from condensing on the surfaces of the cabinet walls.

Already the cabinets and switches have been found to be serviceable for testing a variety of electrical apparatus under high humidity conditions. One cabinet is regularly used for preconditioning samples prior to performing cold flow deformation tests per A.S.T.M. Method D 621.[4]

Acknowledgment:

This development was carried out under the direction of L. B. Butterfield, and its success was due in no small measure to the cooperation of C. E. Ohlheiser of the American Instrument Co. who took a personal interest in the cabinet design, and of H. A. Rawlins and H. J. von Hasseln and members of the Materials Testing Laboratory, all of the Western Electric Co., Kearny Works, who contributed engineering, design, and testing effort, respectively.

[4] Tentative Methods of Test for Deformation of Plastics Under Load (D 621 – 48 T), 1949 Book of A.S.T.M. Standards, Part 6, p. 496.

Courses in Appearance Measurement

The Henry A. Gardner Laboratory, Inc., is planning to repeat, in 1950, its educational course on appearance measurement. This course is given at its Bethesda, Md., plant by Richard S. Hunter and other members of the laboratory staff. Last year's program has been enlarged with new lectures. Laboratory facilities for work by students have been enlarged with completion of a new colorimetric goniophotometer and other apparatus.

The course considers appearance from the point of view of its physical causes, its psychological appreciation, and its psychophysical measurement. The course is educational, not promotional. It is intended for workers in fields which vary from manufacture to home economics and plant breeding, and some of the materials dealt with are protective coatings, plastics, ceramics, rubber textiles, and foods. There are ten lectures during the five-day course (Monday through Friday), six dealing with appearance and its scales of measurement, four with instruments used to measure appearance, their design, operation, and maintenance.

Registration fee is $25 to cover lunches and part of the cost of materials used in the course; at least two courses will be given between February 1 and May 31.

Interested persons should write to Henry A. Gardner Laboratory, Inc., 4723 Elm St., Bethesda 14, Md.

Mechanical Properties of Plastics—M.I.T.

Plastics and their mechanical properties as viewed from the standpoint of research, engineering, and architecture will be the subject of a 3-day conference at the Massachusetts Institute of Technology on June 20, 21, and 22, 1950.

Sponsored by the M.I.T. Plastics Committee, the program will provide an opportunity for those interested in but not directly associated with plastics to hear and and participate in discussions of their many properties and uses. Research workers in the field will report their findings for discussion by others engaged in research as well as by engineers involved in plastics applications.

Professor A. G. H. Dietz of the M.I.T. Department of Building Engineering and Construction is chairman of the conference's sponsoring committee.

Papers to be given at the conference will be on subjects which include the theory of visco-elastic behavior in high polymers, static and dynamic properties of rubber-like materials, reaction of polymers and mechanical waves, mechanical properties of plastics, flow markings in polymeric solids, complex stressing of polymers, origin and interpretation of fracture markings in plastic, plastics-based laminates, engineering adhesives, protective and decorative industrial finishes, films and coated fabrics, and resistance of plastics to various service conditions.

Some Applications of Modern Microscopy to the Study of Chemical Phenomena and in the Dyeing and Printing of Textiles[1]

By G. L. Royer[2]

Microscopy is not a new tool in the chemical or textile industry. However, the advent of color photographic methods, such as Kodachrome and Ansco color has made possible the development and presentation of material which would have attracted little attention in black and white. While the publication and printing costs still make it difficult to reproduce color as widely as would be desired, it is practical and economical to use it extensively in lectures. The presentation of technical service information on the use of products and scientific techniques in technical lectures is greatly aided by color photomicrographs.

Equipment

The biological or medical microscope has been the most popular type of microscope. While much work can be done in the chemical and textile field with this instrument, the chemical microscope offers more advantages. This instrument is equipped with attachments so that observations can be made with polarized light and so that many quantitative optical data on materials can be obtained. It approaches the design of the petrographic microscope which has been used for years by the mineralogist in studying the composition and structures of minerals but is somewhat less complex and less expensive. Objectives with magnifications of 10×, 20×, and 40× when used with 5×, 10×, and 20× eyepieces give a wide latitude. An oil immersion objective of high magnification (90 ×) has little use in the chemical field except on special problems. The 20× eyepiece which normally is not used to any extent has been found very useful in our laboratories. Various types of condensers make possible special illumination conditions such as bright- and dark-field transmitted light, ultramicroscope light- and dark-field reflected light and possible color effects by the Rheinberg method (16).[3]

The binocular microscope which utilizes two objectives and two eyepieces is useful for low-power observations since the third dimension is realized. This is of value in examining textiles or chemical mixtures when it is desirable to separate or pick out portions for further detailed examination. Binocular eyepieces alone do not give a true three-dimensional effect but do offer, if properly used, the possibility of less eyestrain.

A more recent development in the light microscope field has been the phase microscope. Bennett, Jupnik, Osterberg, and Richards (2) were the first in this country to develop this instrument, although the original work on phase contrast method in microscopy was developed by Zernike in 1935 (22). By the use of this microscope it is often possible to show up differences in structure which normally are difficult to reveal by the normal bright- or dark-field microscope techniques. It has been shown to be of value in the biological field and in chemical microscopy where the differences in the product vary only slightly in refractive index. In our laboratories it has found use in locating resin deposits on the outer portions of textile fibers (9) and also in differentiating crystalline products in mother liquors whose index was quite similar to that of the crystals (3). This microscope has a use as a special microscopical tool but in itself will not displace the standard bright-field microscope.

The normal use of the microscope is limited to light in the visual range. However, by special techniques and apparatus it is possible to extend its usefulness into the ultraviolet and infrared portions of the spectrum. Ultraviolet systems have not been popular because of the difficulty of focusing and observing by means of photography. Quartz systems have usually increased the cost of the apparatus, and methods of focusing in the visual range with correspondent photography in the ultraviolet range have not been too convenient. Some recent work on reflecting types of objectives in combination with photography in different ranges of the ultraviolet have been developed on a more-or-less automatic basis and converted into colored light images (4, 7). This procedure, at present being used in cancer research, may find value in other fields. The adaption of the "snooperscope" unit is proving of interest for visual observation of infrared images (1, 20). At the present time this is done with the usual glass objectives, but here again improvements are possible by the use of the infrared reflecting objectives which are being developed. The adaptation of these objectives to infrared spectrophotometer systems is making available studies of structure which were not formerly possible.

The electron microscope has been one of the biggest recent developments in the microscopical field and has made possible resolutions of structures of wool for example (8, 9) many times beyond that possible with the light microscope. The use of this instrument with techniques similar to those used in the optical field has given us a better conception of many of the hazy images which we were unable to interpret with the light microscope. This has been particularly true in the field of pigments and in the study of the structures of many biological materials.

An important part of any microscopical examination is the method used to illuminate the sample. The results will depend upon the color of the illumination and also many times upon how well it is adapted to the optical system which is being used. It is unfortunate that more attention has not been given to this important part of microscopy. The condenser system of the lamp being used for illumination is an important part which limits or controls what will be seen under the microscope. Coiled filament tungsten lamps, ribbon filament tungsten lamps, arcs between carbon electrodes, arcs between tungsten electrodes, concentrated zirconium arc, special ultraviolet producing lamps, and high-speed flash lamps are the most important sources of light. The only one of these of recent development is the high-speed flash lamp (5). A special lamp has been developed which can be used in photomicrographic systems so that a very

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[1] Presented at a meeting of A.S.T.M. Committee D-13 on Textile Materials held in Philadelphia, Pa., October 20, 1949. Lecture was illustrated with 100 Kodachrome slides projected by a double projection technique so that two slides shown at the same time could be compared.

[2] American Cyanamid Co., Calco Chemical Div., Bound Brook, N. J.

[3] The bold face numbers in parentheses refer to the list of references appended to this paper.

high light intensity can be obtained in a very short time interval. This makes possible the photomicrography of very rapid-moving materials with good sharpness of image.

Photomicrography

The photography of microscopical observations depends chiefly upon a knowledge of photographic technique and the proper combination of the microscope with the camera (19). This can be as simple as the combination of the camera with its lens set at infinity with a microscope focused at infinity or a very complicated photomicrographic setup with the camera built into the optical system of the microscope. While the latter is very versatile, the former offers simplicity and much lower cost. Any extensive amount of photomicrography can be done with other combinations between these two extremes. Black and white pictures are, of course, simpler to take than those in color chiefly because of the nature of the process. In black-and-white photography the exposures need not be too exact because it is possible to correct for quite large errors in making the print or enlargement from the negative. In color photomicrography the exposures must be quite exact because of the nature of the reversal process used in the modern Kodachrome and Ansco color. However, by the proper use of exposure meters, it is possible to obtain very satisfactory color photomicrographs with relatively simple equipment and limited knowledge.

Uses

A great deal has been done in recent years in the use of the microscope in the field of chemistry. The work of Chamot and Mason (6) can be considered of primary importance in this country. As mentioned earlier, some of the work in chemical microscopy was based on principles evolved in the study of minerals. The identification of chemical materials by use of the microscope depends upon the optical properties of the material. The size, shape, color, and structure are valuable factors in addition to the optical properties, such as refractive index, anisotropy, pleochroism, etc. In addition to the use of these properties for the identification of chemical materials it is possible to use them in a study of their physical chemical properties as related to the use of the material. This use may be either in regard to chemical reactions, in chemical manufacturing, or in the various fields in which the products are applied for final use in textiles, paints, resins, pharmaceuticals, etc.

In the field of dyes, it is possible to consider the dyes as chemicals and use the microscope in the study and control of their manufacture. In addition, the microscope has found extended use in the study of the application of dyes to textile fibers (17). By such studies it is possible to obtain a better understanding of the mechanism of dyeing and to detect faults in application. This makes possible better control and lower cost because of a better understanding of some of the factors which lie behind the art of dyeing. It is possible to use the microscope in the identification of the textile fibers so that the proper dye will be chosen. Dyes are specific in their application and must be chosen for the particular fiber being dyed. If a blend of different fibers is being used, it may be necessary to have several types of dyes present. Semiquantitative estimates of the fiber content and the diameter of the fibers are possible by microscopical techniques. The morphology of the textile fiber is an important factor in controlling the penetration of dye, as, for example, the presence or absence of skin on rayon (12). During the formation of the natural fibers, the biological changes which take place influence the structure. For example, the extent of maturity in the cotton fiber is determined by the thickness of the fiber walls, and fibers of different thicknesses will dye differently (18).

In dyeing, the dye is removed from the bath and migrates between the fibers, finally diffusing within each fiber to combine in some manner with the material of which the fiber is made. The penetration within the fabric is somewhat controlled by the fabric construction, but can be influenced by the physical or chemical nature of the dye. The latter factors are very important in regard to the diffusion into the fiber itself. The microscope has been of value in studying where the dye goes when certain physical and chemical changes are made in the dyeing process. Cross-sections of the finished dyeings and sections of material removed during dyeing make these observations possible. The distribution of the dye from fiber to fiber, which has been termed fiber levelness, has been related to color value and fastness properties, and thus improvements in the final dyeing and dyeing processes have been possible (10, 11, 13, 14, 15, 21).

It is also possible to study the application of dye by the printing process. This is a local application of dye to selected portions of the cloth which is determined by the design. In general the fundamental processes are similar to dyeing, but the physical nature of the surface of the cloth and the shorter times of application make the physical nature of the dyestuff and the textile of prime importance. The color value obtained will depend upon the penetration of the dye into the textile material; the deeper the penetration, the less color value obtained. In other words, it is most desirable to keep the color located on the surface of the cloth where it is most effective. Cross-sectional studies are of considerable value in determining this degree of penetration into the fabric. It is possible to make these sections at various stages during the printing process and to determine those parts of the process which are important with respect to penetration.

Finishing

The final operation on any textile material is normally called finishing. To the customer it is reflected in its feel and appearance. Except from the viewpoint of color, the appearance and the feel are due to the physical characteristics of the individual fibers themselves and the manner in which they act together. In recent years chemical finishes have come to the fore, due to the addition of resins for creaseproofing and shrinkage control. The microscope has been of considerable importance in studying the location of these materials in the textile fiber and fabric so as to have a better understanding of their function. For example, it was recognized early in the application of the urea-formaldehyde resins for creaseproofing that it was desirable to have the resin penetrate within the fiber. By the use of dye techniques combined with the microscope (17), it is possible to show that these resins are within the fiber by the normal methods of application. Deposits of the resin among the fibers and from thread to thread have a tendency to give poor hand due to a stiffening effect. In the application of the melamine type of resin to wool (9) for shrinkage control, it is thought to be desirable to have the resin on the outside of the individual fiber to cover up the scale interstices. Resin within the fiber does not seem to contribute to shrinkage control. Here again too much resin deposited from fiber to fiber will cause a poor hand due to stiffness. The microscope is not of value in determining the physical properties of plasticity and the stress-strain characteristics of the individual fibers, but it is of value in interpreting morphological changes and the location of modifying agents which greatly modify these properties.

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Some Instruments for Measuring the Dynamic Mechanical Properties of Plastic Materials[1]

By Lawrence E. Nielsen[2]

It is gradually being realized in the field of mechanical testing that dynamic tests have much to offer. Dynamic tests have been used in the metals and rubber industries for some time, but only recently have they been applied to the testing of plastic materials (1–7).[3] This increased use is not difficult to visualize since nearly all objects are subjected to variable stresses or vibrations of some kind.

In general, a single dynamic test gives two pieces of data—a modulus of elasticity and a damping or energy-dissipation term.

The concept of a modulus is quite well understood by many laymen. The modulus of elasticity, for example, is a measure of the stress accompanying a unit deformation, and for materials obeying Hooke's law is the ratio of stress to strain. A more general concept of a modulus of elasticity is that it is a measure of the potential energy stored in a material by a unit deformation. The concept of mechanical damping is more foreign to most people, however. In all real materials, Hooke's law is not perfectly obeyed; part of the energy required to deform a substance is not stored as recoverable potential energy but is expended in the generation of heat. It is this loss of energy in the form of heat which brings about mechanical damping. There are numerous ways of expressing damping. Some of these are defined in terms of heat generated and others by the ratio of the energy dissipated as heat to the energy stored as potential energy. For audio and subaudio frequencies of applied stresses, a very convenient way of expressing damping is by a mechanical dissipation factor—the ratio of the imaginary part of a modulus of elasticity to the real part of the modulus. This is analogous to the electrical dissipation factor defined as an imaginary dielectric constant divided by the real part of the dielectric constant. The mechanical dissipation factor can be easily calculated from such experimentally determined quantities as the logarithmic decrement of mechanical vibrations or the half width of a resonance peak.

Two types of dynamic apparatus will be described in which the applied stresses vary sinusoidally at a rate from sub-

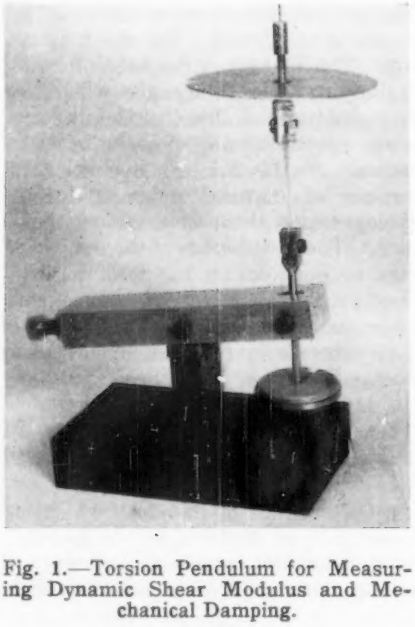

Fig. 1.—Torsion Pendulum for Measuring Dynamic Shear Modulus and Mechanical Damping.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or the attention of the author. Address all communications to A.S.T.M. Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] This paper was presented at a Meeting of Subcommittee VIII on Research of Committee D-20 on Plastics, held in New York City on November 1, 1949.

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[3] The boldface numbers in parentheses refer to the list of references appended to this paper.

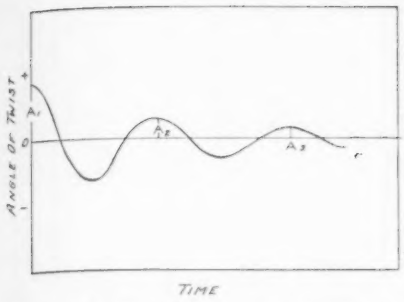

Fig. 2.—A Typical Damped Oscillation Obtained with the Torsion Pendulum.

$$\delta = ln A_1/A_2 = ln\ A_2/A_3$$

audio up into the audio range of frequencies. The first of these is a torsion pendulum from which can be calculated a shear modulus and a mechanical damping term. The second is a resonating reed vibrator which can be used to calculate a Young's modulus of elasticity and mechanical damping for rigid films or fibers.

Torsion Pendulum

The torsion pendulum is illustrated in Fig. 1. It is similar to one described by Kuhn (8). A clamp for the upper end of the test specimen, a fine pointer, and a disk of known moment of inertia are suspended by a fine wire (the fine suspension wire is not visible in the photograph). The lower end of the specimen is attached to a clamp free to move in a vertical direction but not in the horizontal direction. This clamp holder has two sets of miniature pivot bearings (manufactured by the Miniature Precision Bearings, Inc.)

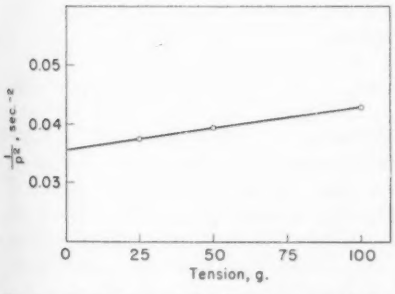

Fig. 3.—Variation of the Reciprocal of the Square of the Period of the Pendulum with Tensile Load on the Specimen.

which create very little friction for vertical movement but which prevent any rotation of the lower clamp in a horizontal plane. This type of holder is necessary because a specimen tends to shrink in length when twisted, and a variable tensile force would be applied to the specimen as it twisted and untwisted if such a clamp were not used. Such a tensile force tending to elongate the specimen would make the pendulum oscillate at a faster rate, thus giving a false shear modulus higher than the true modulus. For this reason, the clamp was designed so that weights could be added which would give a known tensile load. By carrying out the test at three or more weights, it is possible to perform an extrapolation which gives the period of the oscillation at zero tension on the specimen.

The torsion pendulum is extremely simple in operation. A known weight is added to the lower clamp. The upper part of the apparatus with the upper clamp and moment of inertia disk is given a twist of about 45 deg. and released. Unless the damping of the specimen is very high, the system will oscillate, thus twisting and untwisting the specimen. The period of the oscillation is timed to 0.01 sec. The amplitude of each oscillation is less than the one before. A fine wire pointer just above the moment of inertia disk is used to measure the angle of twist of each oscillation on a protractor 6 in. in diameter. (In order better to show the apparatus, this protractor, which is separate from the oscillating system, has been omitted in the photograph of the apparatus.)

Figure 2 is a typical curve of angle of twist *versus* time. The period is the time required for one complete oscillation. The logarithmic decrement δ is defined as the natural logarithm of the ratio of two successive maximum positive angles of twist. For instance, from Fig. 2, $\delta = ln\ A_1/A_2 = ln\ A_2/A_3$. The logarithmic decrement is one way of expressing the damping and can be expressed in terms of the mechanical dissipation factor G''/G' by means of the approximate equation

$$\delta = \pi G''/G'$$

G'' and G' are defined by the complex shear modulus

$$G^* = G' + iG'' \quad \ldots\ldots(1)$$

G^* is the complex shear modulus, G' the real part of the shear modulus, G'' the imaginary part of the modulus, and $i = \sqrt{-1}$. Except in the case of very high damping, $G^* = G'$.

It can be shown[4] (9) that for small angles of twist and zero tension on the specimen, the shear modulus G′ can be calculated from the equation

$$G' = \frac{I}{kP_0^2}(4\pi^2 - \delta^2) \ldots\ldots(2)$$

where:

I = moment of inertia of the oscillating system,
P_0 = the period with no tension on the specimen, and
k = a constant depending on the size and shape of the specimen.

For specimens of rectangular cross-section

$$k = \frac{cd^3\mu}{16L}$$

For specimens of square cross-section and circular cross-section, respectively,

$$k = \frac{S^4}{7.11L}$$

and

$$k = \frac{\pi R^4}{2L}$$

where:

c = width of specimen,
d = thickness of specimen,
L = length of specimen,
S = length of side for a square specimen,
R = radius of circular specimen, and,
μ = shape factor, values of which are given in Table I (9).

For specimens of rectangular cross-section for which the logarithmic decrement is less than one, the shear modulus can be calculated from

$$G' = \frac{38.54LI}{cd^3\mu} \cdot \frac{1}{P_0^2} \ldots\ldots(3)$$

G' has the dimensions of dynes per square centimeter, while L, c, and d are in inches, and P_0 is given in seconds. I has the dimensions of gram square centimeters.

The torque, T, required to twist a specimen of rectangular cross-section through a small angle, θ, when there is no stretching force applied to it is given by

$$T = \frac{cd^3\mu G\theta}{16L}$$

However, if tension is applied to the specimen and if the angle of twist is large, Timoshenko states (10) the torque is

$$T = \frac{cd^3\mu G'\theta}{16L} + \frac{c^3d\sigma\theta}{12L} + \frac{E}{360}c^5d(\theta/L)^3 \ldots(4)$$

where:

σ = tensile force, and
E = Young's modulus.

This equation indicates that the proper period to be used in calculating the modulus is the one in which $\sigma = 0$. It is easily shown that a plot of $1/P^2$ against the tensile force should give a straight line as indicated in Fig. 3. The intercept $1/P_0^2$ is used in the calculation of the modulus.

The experimental value of the log-

[4] This is readily derivable from the equation of motion $\frac{Id^2\theta}{dt^2} + KG^*\theta = 0$, or if damping is neglected by substituting into the general equation $F = \frac{1}{2\pi}\sqrt{\frac{KG}{I}}$, where F is the frequency of oscillation.

TABLE I.—VALUES OF μ.

Ratio of Specimen Width to Thickness	Shape Factor, μ	Ratio of Specimen Width to Thickness	Shape Factor, μ
1.00	2.249	3.50	4.373
1.20	2.658	4.00	4.493
1.40	2.990	4.50	4.586
1.60	3.250	5.00	4.662
1.80	3.479	6.00	4.773
2.00	3.659	7.00	4.853
2.25	3.842	8.00	4.913
2.50	3.990	10.00	4.997
2.75	4.111	20.00	5.165
3.00	4.213	50.00	5.266
		100.00	5.300

arithmic decrement also varies with stretching force on the specimen, so that the extrapolated value of δ at $\sigma = 0$ is used as being characteristic of the material. A plot of $\sqrt{\delta}$ *versus* σ generally gives a fairly straight line.

The torsion pendulum can be operated over the frequency range from about $\frac{1}{50}$ to 2 cycles per second. With a moment of inertia between 100 and 20,000 g. sq. cm., typical specimen dimensions are 2 in. long, $\frac{1}{4}$ in. wide, and 0.025 in. thick for materials covering the usual range of shear moduli found in high polymeric materials.

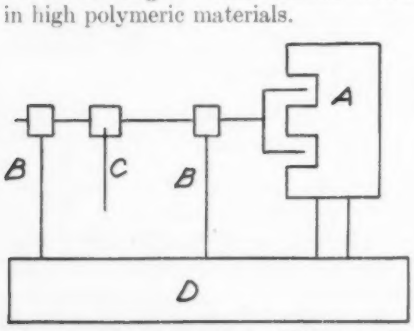

Fig. 4.—Electromagnetic Vibrator for Measuring Dynamic Young's Modulus and Mechanical Damping.

A = Speaker coil and magnet.
B = Leaf springs.
C = Sample reed.
D = Heavy base.

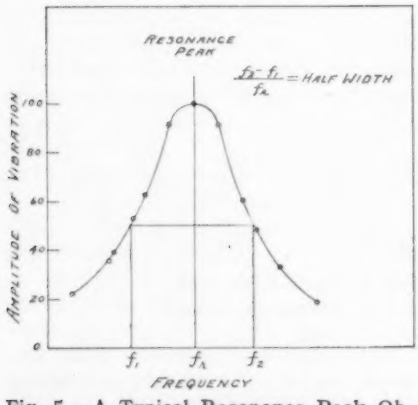

Fig. 5.—A Typical Resonance Peak Obtained with a Plastic Reed in the Electromagnetic Vibrator.

If the damping becomes extremely high, the pendulum will no longer oscillate. However, by changing the flexible suspension wire to a more rigid

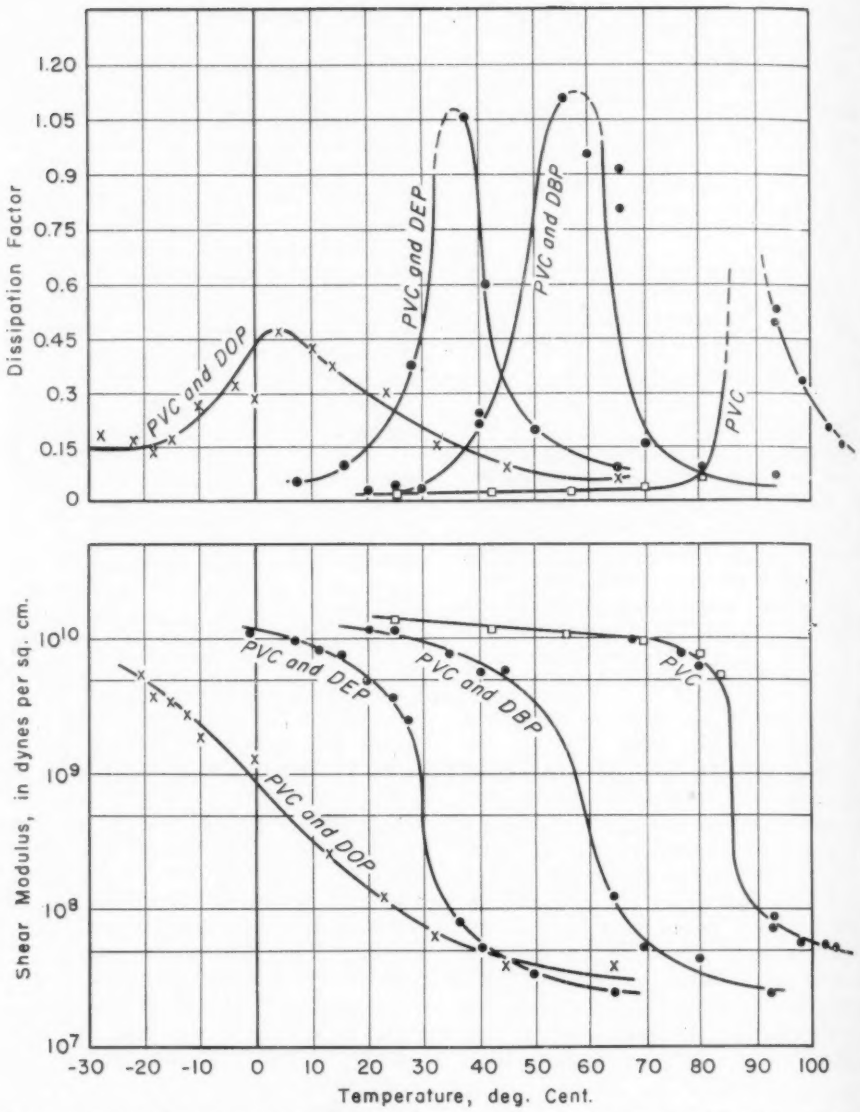

Fig. 6.—Shear Modulus and Mechanical Damping (Dissipation Factor G''/G') for Polyvinyl Chloride Systems.

one, the pendulum can be forced to oscillate. Then the shear modulus in dynes per square centimeter is given approximately by

$$G' = \frac{38.54LI}{cd^3\mu}\left(\frac{1}{P_S{}^2} - \frac{1}{P_A{}^2}\right) \ldots (5)$$

where the specimen dimensions are given in inches. P_A is the period of the stiff wire pendulum with no specimen, and P_S is the period with the specimen. In order to calculate the damping, it is now necessary to make certain assumptions, the least drastic of which is to assume that all the damping is due to the specimen. If the assumption is made that the experimentally determined logarithmic decrement is given by

$$\delta_{exp.} = \pi \frac{G''_S}{G'_S + G'_A}$$

then the true logarithmic decrement of the specimen is

$$\delta_S = \delta_{exp.} \frac{P_A{}^2}{P_A{}^2 - P_S{}^2} \ldots (6)$$

In view of all the assumptions and approximations involved in calculating the damping when such large values of the logarithmic decrement are involved, it is somewhat questionable if the values have much quantitative significance, however.

A recording torsion pendulum is now being developed with which the frequency and amplitude of the oscillations will be traced on the chart of a recorder such as the Brush Development Co.'s magnetic oscillograph. The mechanical vibrations are converted to electrical potentials, for instance, by means of an RCA No. 5734 mechano-electronic transducer tube attached to the lower clamp.

Resonating Reed Vibrator

A very simple dynamic testing apparatus is the resonating-reed vibrator.

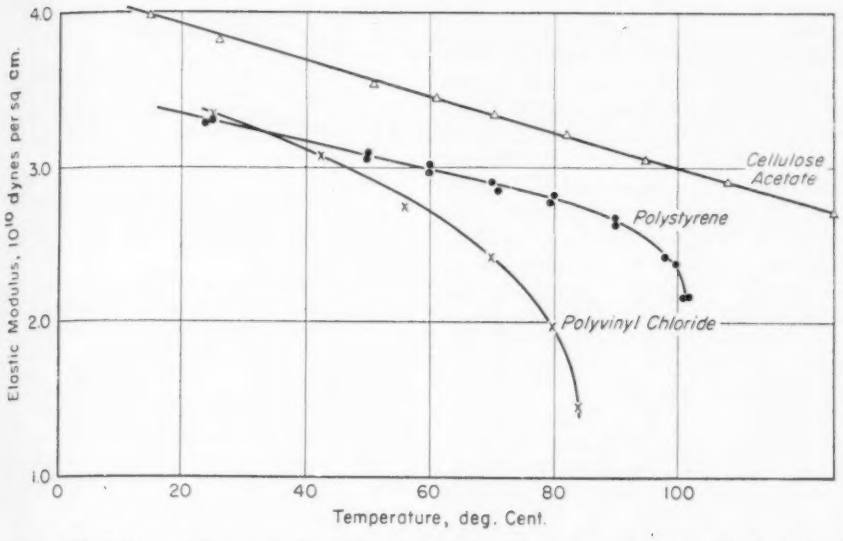

Fig. 7.—Variation of Dynamic Young's Modulus with Temperature for Unplasticized High Polymers.

A sketch of this apparatus is shown in Fig. 4. A common 12-in. permanent-magnet loud-speaker may be used as the main part of an electromagnetic vibrator. A small rod, supported by leaf springs, is attached to the voice coil of the speaker. The speaker cone can either be removed or left in place, but, in general, fewer resonance frequencies of the apparatus will be found if the cone is removed. The clamp for holding the specimen, which may be a strip of film, a reed, or fiber, is fastened to this vibrating rod. The vibrator may be driven from about 10 cycles per second to several hundred cycles per second by a good class A power amplifier, which, in turn, is driven by an audio oscillator. Similar vibrators have been reported recently (1, 2).

The amplitude of the free end of the vibrating cantilever reed is measured with a low-powered microscope with a micrometer eyepiece. It is only necessary to measure this amplitude in arbitrary units. As the frequency of the applied force is increased, the amplitude of the vibrations of the reed will increase, go through a maximum, and then decrease in a manner similar to that shown in Fig. 5. A Young's modulus may be calculated from the resonance frequency f_r, of the reed. (The resonance frequency is that frequency where the amplitude is a maximum.) The damping can be calculated from what is usually called the half width of the resonance peak. There are two frequencies on this resonance peak where the amplitude is one half the maximum amplitude. The half width is defined as the difference between these two frequencies divided by the resonance frequency. The half width of the resonance peak can likewise be expressed as the ratio of the imaginary to the real part of a modulus by the equation

$$\frac{f_2 - f_1}{f_r} = \sqrt{3}\,\frac{E''}{E'} \quad \ldots\ldots (7)$$

Here E' and E'' are the real and imaginary parts of Young's modulus, respectively; these are analogous to the G' and G'' discussed in connection with the torsion pendulum. This equation is nearly exact for small values of damping but becomes less and less accurate as the damping increases

For a cantilever reed of rectangular cross-section, the modulus may be calculated from the equation (11):

$$E = 38.24\rho\,\frac{l^4}{d^2}\,f_r^2 \quad \ldots\ldots (8)$$

where:

E = Young's modulus in dynes per square centimeter,
ρ = density of the material,
l = free length of the reed, and
d = thickness of the reed in centimeters.

For most rigid plastic materials, reeds of from 1 to 3 in. long and thicknesses of 0.005 to 0.020 in. give resonance frequencies in the neighborhood of 25 cps. The width of the reed is unimportant, but $\frac{1}{8}$ to $\frac{3}{8}$ in. makes a convenient width if the material is in the form of a film.

In most cases, the vibrator itself will have a resonance frequency some place in the usable frequency range. This, in general, is not harmful since these peaks can be made very sharp, and it is only necessary to have the reed dimensions such that it resonates at a frequency some distance from the natural frequency of the apparatus.

In case the reed has a damping so great that the amplitude of the exciting vibrations changes appreciably in going through the resonance peak, then a correction must be applied. However, for most plastic materials at frequencies removed from the resonance frequency of the apparatus, such corrections may be neglected.

Another possible source of error in the damping is the air losses due to the reed vibrating in air. The ideal method of determining the magnitude of this error would be to carry out an experiment on a low damping material in both air and vacuum, but this was not possible in our case. Other experiments indicate, however, that damping due to the air is small in most cases. A metal reed gave a damping of about that reported in the literature. A series of experiments was carried out on polystyrene reeds of various thicknesses and lengths

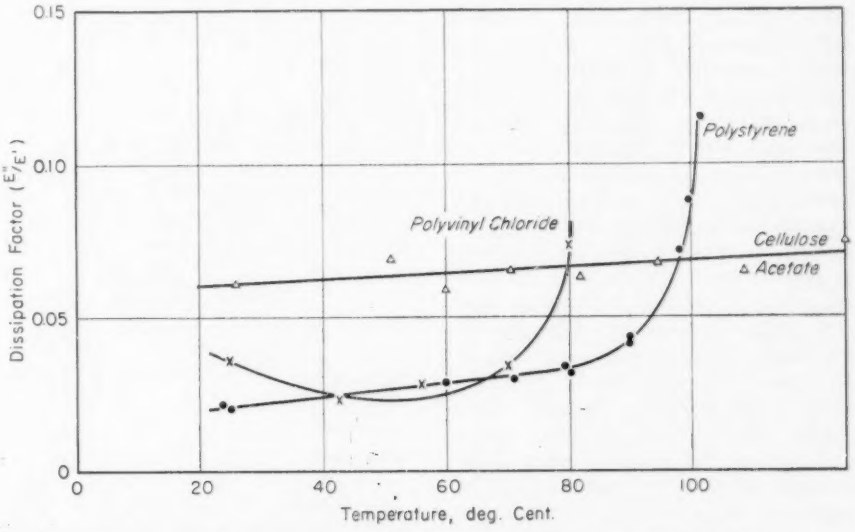

Fig. 8.—Variation of Mechanical Damping (Dissipation Factor E″/E′) with Temperature for the Same Unplasticized High Polymers as Shown in Fig. 7.

over a frequency range. Polystyrene is a good material for such tests since it has a small damping compared to most high polymeric materials. The results indicate that losses due to air damping in the case of polystyrene are about 10 per cent of the total damping.

The effect of temperature on the dynamic properties can be studied by using special temperature boxes. With the torsion pendulum, the whole apparatus, except pointer and protractor, is placed in an oven with a small hole in the top through which the suspension wire goes. In the case of the electromagnetic vibrator apparatus, a small electrically heated oven with a window has been built which surrounds only the specimen and clamp.

Applications

Recently, several practical applications of dynamic tests to the study of high polymers have been reported (**2–7**). Dynamic tests in addition to giving a modulus of elasticity and a damping, which are important in themselves, may also give indications of other properties of the material. For instance Sauer (**3**) and Nielsen (**5**) independently and by entirely different experimental techniques have found a relationship between damping and creep for polystyrene. Furthermore, in general, materials with high damping have high impact strengths. Changes in structure such as orientation may, in some cases, be followed by dynamic tests. High polymers such as polystyrene and polyvinyl chloride have a maximum in the damping *versus* temperature curve in the region where the material changes from a hard, rigid mass to a soft, rubber-like material. The softening temperature may be taken as the temperature at which the damping is a maximum.

Plasticizers may be evaluated with respect to efficiency and low-temperature behavior by dynamic tests carried out over a temperature range. Plasticizers shift the maximum in damping to lower temperatures and at the same time broaden the damping peak. In general two of the most important properties wanted in a plasticizer are a broad damping peak and a large shift in this peak to lower temperatures for a given concentration of plasticizer. Figure 6 gives typical examples of data obtained with the torsion pendulum on plasticized polyvinyl chloride systems. The greater the width of the damping peak, the less sensitive is the modulus to temperature. It will be noted that the shape of the dynamic modulus curve is very similar to that obtained with the apparatus of Clash and Berg (**12**) or Conant and Liska (**13**).

Figures 7 and 8 show the dynamic properties of various plastics as determined with the electromagnetic vibrator operating at a frequency of about 25 cps. In Fig. 8 only the low-temperature part of the damping peak is shown for polystyrene and unplasticized polyvinyl chloride. At slightly higher temperatures, the damping would have gone through a maximum for these materials and would have then decreased to much smaller values again at still higher temperatures in a manner very similar to that shown in Fig. 6.

In summarizing, it may be stated that dynamic tests give more simple basic information than many of the usual tests now used for plastics. Each test gives two pieces of data and not just one, so differences between materials should in general be more easily detected. At the same time, the interdependence of the dynamic properties should help in studies of molecular structure. The tests are relatively simple and can be performed at a rate comparable to other tests and with approximately the same accuracy. Only small amounts of materials are required as the specimens are small, and a large number of replications is not necessary.

Acknowledgment:

It is a pleasure to acknowledge the encouragement and assistance given by N. N. T. Samaras, H. W. Mohrman, Rolf Buchdahl, and others of the Plastics Research Laboratory of the Monsanto Chemical Co.

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The Use of Electrical Measurements to Predict the Mechanical Properties of Plasticized Polyvinyl Resins[1]

By A. J. Warner[2]

THE rapid expansion in the use of plasticized polyvinyl chloride type plastics for such varied applications as primary insulation for wires and cables, protective jackets, films and sheeting, and so forth, has led naturally to a growing desire for a more detailed understanding of the effect of the various ingredients that enter into the compound on the final properties desired. In particular, emphasis is being placed on extending the temperature range over which the materials will be operable, and this has activated detailed studies of their behavior at the extremes of temperature.

The conventional laboratory approach, and one which has yielded much valuable information, is to vary the amounts of the several ingredients in a predetermined manner, prepare test specimens, and make physical and electrical measurements thereon. It has been increasingly evident that this approach does not give as much guidance in the development of new materials as is desirable, and considerable thought has been given, particularly recently, to the basic considerations involved.

The compounds used, in their simplest form, generally comprise the base resin, a plasticizer, and a stabilizer, although in addition lubricants, coloring agents, and fillers may be present. The base resin is either the polymer of vinyl chloride itself, or a copolymer of this material with some other suitable vinyl monomer, such as vinyl acetate, the latter usually being present in a minor amount.

Through much practical experience, the base resins most commonly used have become relatively well standardized, typical examples for wire and cable coverings, for example, being Geon 101 or Vinylite VYNW. The stabilizer, which is present in relatively small quantities principally to retard any tendency toward degradation of the base resin during processing or use, may be one of a variety of materials; but quite commonly it is a metallic salt, such as tribasic lead sulfate, and it may be either soluble or insoluble in the plasticized composition. Apart from its vital importance in the protection of the compound from degradation by heat or weathering, the stabilizer usually has but a minor effect on the physical properties of the compound itself.

The plasticizer, on the other hand, because it is present in a major amount, is of paramount importance, and the final properties of the plasticized composition are primarily dependent on the nature and amount of the plasticizer. It is not surprising, therefore, that much work has been concerned with the synthesis and examination of such materials, and that a large and growing list of plasticizers for vinyl resins is offered to the processor.

This whole question has been the subject of considerable activity by various laboratory groups and this activity is reflected in the large number of publications on this general theme in recent years. The purpose of this paper is to present the results obtained in a study of the electrical properties of the base resin and the plasticizer and to show how such electrical properties can be used to predict certain mechanical properties to be expected in the plasticized composition itself. As a result of this approach, it is possible to determine from the electrical properties of the plasticizer itself, for example, whether or not the particular material under examination will be superior or inferior to currently known materials and therefore will serve to give a more rational approach to the synthesis of improved plasticizers.

The Conventional Plasticizer—Viscosity Approach

It has long been recognized that the problem of studying the plasticization of polyvinyl chloride type plastics is one concerning the viscosity of the base resin itself and the effect on this viscosity of adding another material of lower viscosity. Since the base resin is relatively rigid at room temperatures and suffers thermal decomposition at elevated temperatures, no precise determination of its viscosity has been made by conventional means. Jones[3] and others have estimated, on the basis of extrapolation of solutions of the resin, a value of 10^{16} centistokes or higher, but this estimate is of little help in the general problem, other than to give a fixed reference point. It is not surprising, therefore, that more emphasis has been placed on studies of the viscosity characteristics of the plasticizer itself. Thus, Leilich,[4] in particular, early studied the viscosity and viscosity-temperature characteristics of a number of materials used as plasticizers for polyvinyl chloride and formulated two general guiding principles: (1) a plasticizer is more effective the lower its viscosity, and (2) compounds prepared using the plasticizer are more cold-resistant the smaller is the temperature dependence of viscosity of the pure plasticizer.

H. Jones,[5] in a series of investigations carried out in the period 1942–1945, used this viscosity concept widely, extended the measurements to a wider range of plasticizers, and included several polymers other than polyvinyl chloride. He recognized, particularly in his later work, that the plasticizer-viscosity theory was limited somewhat in its applicability to any particular set of conditions, but maintained a general belief in its practical usefulness. The discovery of the so-called polymeric plasticizers and their ability, despite very high room temperature viscosity, to impart good low-temperature properties to polyvinyl chloride type plastics, has made this simple approach less useful.

Earlier Studies on Electrical Properties

Another approach to the problem exists in the use of electrical measurements. Should one measure the property known as the dissipation factor

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] This paper was presented at a meeting of Subcommittee VIII on Research of Committee D-20 on Plastics held in New York City on November 1, 1949.

[2] Technical Director, Chemical and Physical Laboratories, Federal Telecommunication Laboratories, Inc., Nutley, N. J.

[3] H. Jones and E. Chadwick, "Some Physico-Chemical Aspects of Plasticizer Action," *Journal*, Oil and Colour Chemists' Association, Vol. III, June, 1947.

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[5] H. Jones, (*a*) "Plasticizers in Rubbers and Plastics," paper read before a joint meeting of the Institute of the Plastics Industry and the Institution of the Rubber Industry, November 27, 1944, the Engineers' Club, Manchester, England.
(*b*) M.O.S. *Memorandum No. 8*, 1946, "Plasticizer—Polymer Interaction."
(*c*) "Plasticizers in Rubbers and Plastics," *Transactions*, Inst. Rubber Ind., Vol. 21, p. 298 (1946).

(tan δ) of a polar material at a constant frequency but over a temperature range, a region known as the region of anomalous dispersion in which the value rises to a maximum (tan $\delta_{max.}$) is obtained. In the case of simple polar liquids the maximum may be sharp; in more complex materials it may be quite broad. In general, by suitable care in preparation and measurement, sufficiently sharp peaks can be measured to enable the temperature at which the dissipation factor is a maximum to be recorded relatively accurately. In an earlier paper,[6] we discussed this question and the reader is referred there for further information on the general subject.

Quite early, Davies, *et al.*,[7] recorded the results on some plasticized compositions of polyvinyl chloride and showed that increasing the amount of plasticizer present decreased the temperature at which the dissipation factor of the compound was a maximum. Würstlin a little later[8] extended these measurements and correlated the results he obtained with the viscosity of the plasticizer approach made by Leilich. He further showed that the same relationship existed between the temperature of the dissipation factor maxima and the low-temperature properties.

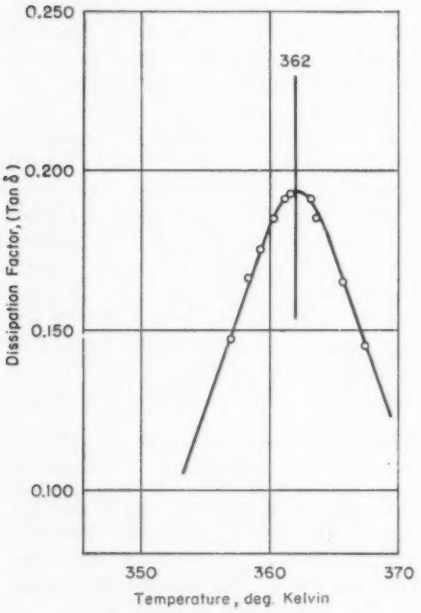

Fig. 1.—Dissipation Factor (Tan δ) *versus* Temperature in Base Plastic.

0.8 parts stabilizer, 2.4 parts lubricant, 46.3 parts vinylite VYNW.

[6] A. J. Warner, "Electrical Properties of Plastics," ASTM BULLETIN, No. 153, August, 1948, p. 60 (TP152).

[7] J. M. Davies, R. F. Miller, and W. F. Busse, "Dielectric Properties of Plasticized Polyvinyl Chloride," *Journal*, Am. Chemical Soc., Vol. 63, p. 361 (1941).

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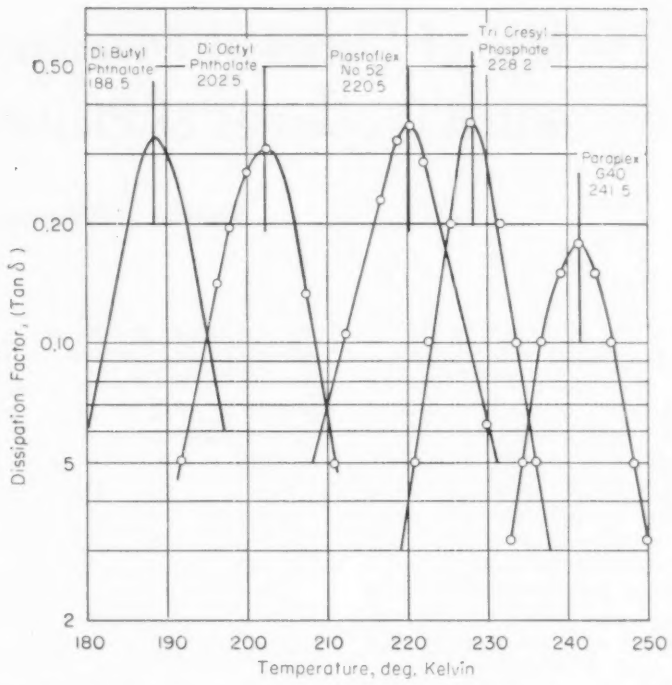

Fig. 2.—Dissipation Factor (Tan δ), *versus* Temperature for Some Plasticizers.

The Relationship Between Plasticizer, Base Resin, and Plasticized Composition from the Electrical Standpoint

In this paper we propose to amplify and extend this electrical approach and attempt to show how such electrical measurements can be used to considerable practical advantage.

As a first approximation, we can consider the base resin as a liquid of high viscosity; to get some measure of this viscosity, we can cause the dipoles present in the molecular structure to oscillate in an electrical field of fixed frequency and by changing the temperature find the one at which the dissipation factor is a maximum. This then affords a reference point for our further experiments on plasticization.

The resin which we have used in our experimental work is the copolymer of vinyl chloride and vinyl acetate, known generally as Vinylite VYNW, and Fig. 1 shows the results obtained for the dissipation factor of this material containing the necessary amount of stabilizer to prevent thermal degradation, measured at a frequency of 60 cycles per second as a function of absolute temperature. The maximum occurs at a temperature of 362 K. (89 C.). Repeated checks on specimens of the same batch of polymer prepared in identical fashion show that this value can be reproduced to better than ± 0.5 C.

Since the plasticizers used for making plasticized polyvinyl chloride type plastics are also polar, by using a similar technique we can obtain a discrete temperature at which they also show a dissipation factor maximum. Figure 2 shows the results obtained on five representative liquids; these indicate that the maxima for the plasticizers occur at temperatures considerably lower than for the base plastic and that there are quite large differences among the various plasticizers.

Having now established the two extremes of our compounds, namely, pure resin and pure plasticizer, and assuming that we can use the temperature at which the dissipation factor is a maximum as a measure of the viscosity, it should be possible to predict what should happen when various amounts of plasticizer are added to the base resin. This prediction is also dependent on the two materials mixing, and we will return to this point later.

Let us designate the temperature at which the dissipation factor of the base resin is a maximum as T_b and the corresponding temperature for the plasticizer as T_p. Then if we mix a volumes of the plasticizer with b volumes of the base resin and assume that the reciprocal of the absolute temperature of the mixture is a function of the volume per cent of the components present, the temperature at which the mixture should have a dissipation factor maximum (T_m) will be given by the expression:

$$\frac{1}{T_{m\ (\text{calculated})}} = \frac{a}{a+b}\left(\frac{1}{T_p}\right) + \frac{b}{a+b}\left(\frac{1}{T_b}\right)$$

or

$$\frac{1}{T_{m\ (calculated)}} = \frac{1}{a+b}\left(\frac{a}{T_p} + \frac{b}{T_b}\right) \quad \ldots (1)$$

By rearrangement, T_m is given by:

$$T_{m\ (calculated)} = \frac{(a+b)T_pT_b}{T_ba + T_pb}$$

Validity of Approach

Since it is easy enough to make the practical experiment of mixing known amounts of plasticizer with a known amount of base resin and to measure the actual value of T_m, we can arrive at some conclusions concerning the validity of Eq. 1.

Let us take two examples at this time, namely, dioctyl phthalate and tricresyl phosphate.

The details of the actual experiments and measurements made are as follows:

	Dioctyl Phthalate	Tricresyl Phosphate
T_b	362 K.	362 K.
T_p	202.5 K.	228 K.
a	29.0	24.5
b	49.5	49.5
$T_{m\ (observed)}$	286 K.	303 K.
$T_{m(calculated)}$	280.1 K.	303.1 K.

It will be seen that very good agreement between the calculated value for T_m and that observed is obtained for tricresyl phosphate but that in the case of dioctyl phthalate the agreement is far from good.

Experiments conducted with a number of other plasticizers of various chemical types showed that considerable deviation from the results expected from Eq. 1 exists. It is interesting to note, however, that in the majority of cases the deviation from Eq. 1 is toward a *higher* observed temperature, and in those cases where a lower value is recorded, the deviation is small.

The k Value—A Measure of the Plasticizer Potential

It was felt that this deviation is in itself significant, and examination of the results of a number of experiments indicated that one could use this deviation as a measure of the ability of a plasticizer to exert its potential effect on the lowering of the viscosity of the base resin. Since this concept will undoubtedly give rise to controversy, we have chosen at this time not to give any particular name to this measure, pending closer examination of its significance, but have merely called it the k value, and it is derived from the following expression:

$$k = \frac{T_b - T_{m\ (observed)}}{T_b - T_{m\ (calculated)}} \quad \ldots (2)$$

where the symbols have the meanings ascribed heretofore.

Obviously when $T_{m\ (observed)}$ is the same as $T_{m\ (calculated)}$, the k value is unity, and for the more general case of $T_{m\ (calculated)}$ smaller than $T_{m\ (observed)}$, k is less than unity.

TABLE I.—PLASTICIZED POLYVINYL CHLOROACETATE.

Plasticizer	T_p, deg. Kelvin	T_m (observed), deg. Kelvin	k value	Brittle Point, deg. Kelvin
Polyester of 1.2-propylene glycol and sebacic acid (G-25)	238	302	1.05	256
AP-53	233	301	1.04	253
Trioctyl phosphate	175	258	1.04	221
Methyl pentachlorostearate	228	304	1.00	273
Tricresyl phosphate	228	303	0.99	273
Celluflex M179C	230.5	305	0.98	281
Dioctyl sebacate	175	258	0.98	217
Celluflex M142	236.5	310	0.98	281
Celluflex M179A	229	305	0.97	277
Paraplex G 40	243	311	0.97	273
Dibutoxyethyl sebacate (Monoplex No. 7)	181	269	0.94	217
Celluflex M179	227	302	0.94	277
Dinormal octyl phthalate (Dinapol)	193	279	0.93	239
Di-(2-ethylhexyl)-phthalate	202.5	286	0.93	241
Plastoflex No. 52	220.5	301	0.88	263
Dibutyl phthalate	188.5	284	0.88	247
Dialkyl ester of long chain dibasic acid (Monoplex No. 11)	193	288	0.86	251
Monoplex No. 10A	192	286	0.86	251
Di-(2-ethylhexyl) tetrahydrophthalate (Flexol 8HP)	197.5	288	0.86	241
Plastoflex No. 50	205.5	299	0.81	261
Plastoflex No. 55	191.5	303	0.66	249

TABLE II.—POLYVINYL CHLOROACETATE PLASTICIZED WITH G-25.

Plasticizer Content, per cent	T_p, deg. Kelvin	T_m (calculated), deg. Kelvin	T_m (observed), deg. Kelvin	k value
36.1	238	304.8	302.0	1.05
49.0	238	288.3	286.3	1.03
51.2	238	285.8	283.2	1.03
53.7	238	282.8	280.0	1.05
56.0	238	280.3	275.5	1.03

TABLE III.—POLYVINYL CHLORIDE PLASTICIZED WITH TRICRESYL PHOSPHATE.

Plasticizer Content, per cent	T_b, deg. Kelvin	T_p, deg. Kelvin	T_m (calculated), deg. Kelvin	T_m (observed), deg. Kelvin (Würstlin data)	k value
0	363	...	...	...	...
15	363	228	329.8	333	0.90
20	363	228	320.3	323	0.94
25	363	228	311.2	315	0.93
30	363	228	303.4	308.5	0.91

In Table I is given a consolidation of the data obtained on a number of plasticized compositions, arranged in descending order of k value, from which it can be seen that k varies from 1.05 for the polymeric plasticizer G-25 to 0.66 for the material marketed under the trade name of Plastoflex No. 55. A further study of this table reveals some other data which should be of great interest to developers of new plasticizers as giving some indication of the particular molecular groupings requisite for improved materials. In general, the sebacates have high values for k; in fact, with the exception of the dibutoxyethyl derivative, the values are all above 0.95. The phosphates, too, seem to have values close to unity, and it is interesting to see the influence of the various isomeric mixtures used in the preparation of tricresyl phosphate. Thus, the various M179 materials are all believed to be essentially tricresyl phosphate, and the experimental data would seem to bear this out. Not only are the T_p values all close together, within ±2 C., but the k values vary only from 0.94 to 0.99. The phthalates have lower k values, of the order of 0.90, and hydrogenation, as in di-(2-ethylhexyl)tetrahydrophthalate, seems to reduce this value still further.

The Uniqueness of the k Value

Before proceeding with the further use to which the T_p and k values can be put, an examination of the validity of the number derived as the k value would seem to be in order. In many of the theories and expressions so far adduced for plasticizer-polymer interaction relationships, so-called constants have been derived whose values are often not fixed but are somewhat dependent on the particular experimental conditions used. Since the k value is given as a number, and this is derived by measurements on a number of compounds having approximately the same plasticizer-resin ratio, we have considered how this number is affected by varying the relative amounts of plasticizer and base resin present over a range commensurate with that of normally used compositions.

In Table II we list the data obtained on a series of G-25 plasticized stocks, in which the plasticizer content varies from 36.1 to 56.0 parts by volume. The corresponding k values show remarkably

good agreement indicating that the k value, once determined for a single concentration, can be used for determining the $T_{m\ (observed)}$ of a compound having a different plasticizer-resin ratio, solely by the use of the measured T_p and T_b values.

It might be argued that this agreement is fortuitous and that our $T_{m\ (observed)}$ values might have been influenced by an innate desire to obtain the results given. We have, therefore, chosen to use some observed data of Würstlin for polyvinyl chloride plasticized with tricresyl phosphate and, together with our value of T_p for this plasticizer, to calculate the corresponding k values for this system. The results are given in Table III from which it will be seen that again we get a k value which can be considered constant over a wide concentration range and that we therefore seem to be justified in asserting the uniqueness of this parameter.

It is also interesting to observe that the k value for the system polyvinyl chloride–tricresyl phosphate is distinctly lower than the k value for the system polyvinylchloroacetate–tricresyl phosphate, an observation which is in line with the practical knowledge that the copolymer requires less of a given plasticizer for a given low-temperature behavior than the straight polymer.

Correlation of Brittle Point, Flex Temperature, and the Temperature of the Dissipation Factor Maximum

Turning now to the consideration of the use to which these electrical measurements can be put in studying the low-temperature behavior of plasticized compositions, Table I also lists the corresponding statistical brittle points for the compounds measured in accordance with A.S.T.M. Method D 746.[9] According to the earlier viscosity theories of plasticizer performance for low-temperature use, the lower the viscosity of the plasticizer the better its probable low-temperature behavior.

In Fig. 3 we have attempted to plot the viscosities of the various plasticizers used against the observed brittle points for a series of compounds all containing the same ratio of plasticizer to resin by weight. It will be seen that no satisfactory curve can be drawn to fit the observed values. Should we, however, plot the $T_{m\ (observed)}$ value against the brittle point, then as seen from Fig. 4, a reasonably straight-line relationship can be developed. The scatter of the data is probably due more to inherent experimental difficulties in making the

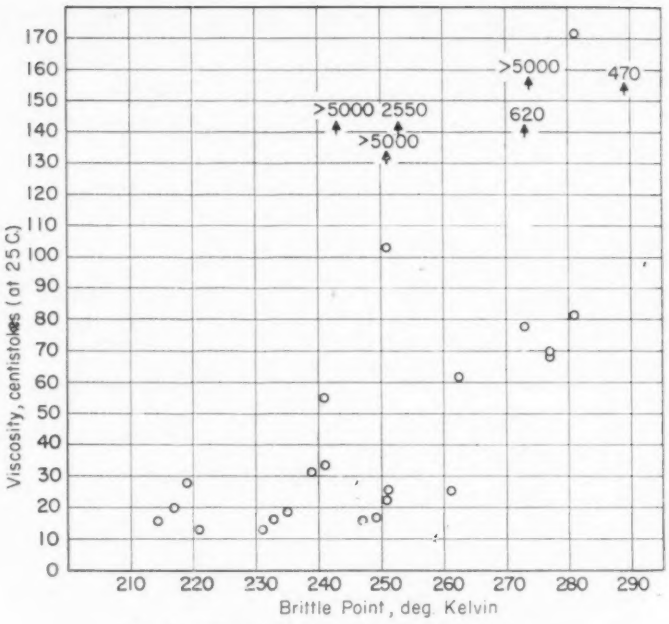

Fig. 3.—Plasticized Polyvinyl Chloroacetate.
Viscosity of plasticizer as a function of brittle point temperature.

measurements than to deviations from such a relationship. As a further extension of the use of the $T_{m\ (observed)}$ values, we have used data given by Reed, *et al.*,[10] for the so-called T_f values (flex temperature) for a number of compounds of composition corresponding to those on which we had measured the electrical data, and Fig. 5 shows the result of plotting T_f against $T_{m\ (observed)}$. Again a reasonably straight-line relationship develops. It is then apparent that in the measure of T_m we have a means of predicting the low-temperature behavior of plasticized compositions as reflected by such measurements as brittle point and flex temperature.

Since we have already demonstrated that the k value is a constant over a wide range of compositions, and the $T_{m\ (observed)}$ can be calculated from a knowledge of the amounts of plasticizer and base resin used, the T_p and the T_b values (using Eqs. 1 and 2), it is apparent that we are now in a position, once having obtained the k value for any particular plasticizer-base plastic system, to predict the low-temperature properties of any compound in this system without further measurement.

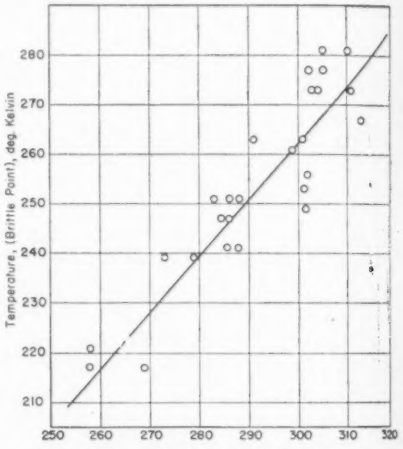

Fig. 4.—Plasticized Polyvinyl Chloroacetate.

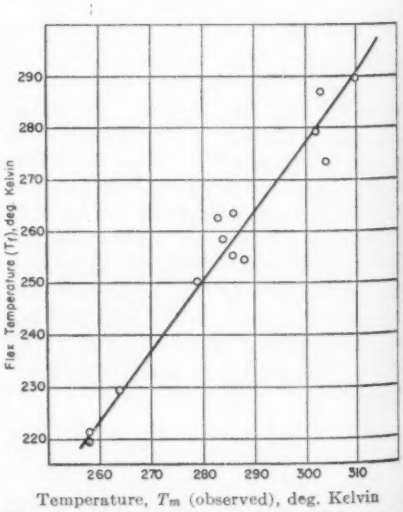

Fig. 5.—Plasticized Polyvinyl Chloroacetate.
Tf data from Reed, *et al.*, *Industrial and Engineering Chemistry.*

Significance and Usefulness of T_p and k Values

Of more interest, however, is a study of the T_p values and the corresponding k values. It is apparent from Table I that should the k values of all plasticizers be the same, then the low-temperature properties of the plasticized com-

[9] Tentative Method of Test for Brittle Temperature of Plastics and Elastomers (D 746 - 44 T), 1949 Book of A.S.T.M. Standards, Part 6, p. 546.

[10] M. C. Reed and L. Connor, "Behavior of Plasticizers in Vinyl Chloride Acetate Resins," *Industrial and Engineering Chemistry*, Vol. 40, p. 1414 (1948).

pounds would be in direct relationship with the value of T_p. In attempting to synthesize new plasticizers or to study materials offered for test, a quick determination of T_p will serve conveniently as a means to screen out any obviously unsuitable material for low-temperature work. Thus it is apparent that a plasticizer having a T_p value higher than 250 K. has no advantage over any existing materials (at least technically if not "pricewise") since (even assuming it had the highest value of k, say 1.05) it would not produce compounds of comparable low-temperature properties to, say, tricresyl phosphate, with the same plasticizer-resin ratio. On the other hand, the mere fact that a suggested plasticizer has a very low T_p value does not automatically insure that it will produce compounds of superior low-temperature properties since the latter will depend on the k value.

Using the above considerations, it is believed that any new plasticizer can be usefully classified by measuring its T_p and k values for a fixed composition and comparing these with the values already established in Table I. As a further study of the influence of structure of the plasticizer molecule on its probable performance as a plasticizer, it is obvious that by taking selected members from a number of homologous series, one could analyze the effect of increasing chain length, chain branching, and so forth, on the properties and thus determine the optimum structure for any particular series. Work of this character is already under way in our laboratories.

An Example:

As a concrete example we can take the sparse data of Table I for the phthalates. We have already observed that the hydrogenation of the benzene ring to form the corresponding tetrahydro derivative, although improving somewhat the T_p value, causes a marked decrease in k, and therefore compounds prepared from this plasticizer show no great advantages from a low-temperature standpoint over the unhydrogenated material.

Increasing the alkyl chain length of the molecule apparently causes an increase in T_p, which is not surprising, but also improves somewhat the k value. It would be interesting to see whether there is an optimum in the dialkyl phthalate series and, if so, where in the chain length and at which particular configuration it occurs.

Perhaps the most striking effect of structural change is to be found in the phosphate series, where the change from triaryl to trialkyl phosphate not only produces a lower T_p but also improves the k value, so that trioctyl phosphate is one of the most effective plasticizers from a low-temperature standpoint. This fact is of course not new, practical experiments having demonstrated this at the time of its development.

Conclusion

In all of the above discussions it should not be overlooked that the electrical approach to the study of plasticized systems is offered only as a guide to further, more intensive work and that other considerations in plasticizer technology, volatility, moisture sensitivity, and so forth, must be studied in the normal manner. The results discussed above demonstrate the usefulness of the electrical approach to the general problem of the plasticization of polar polymers and in particular it is believed that the k value concept introduced affords a relatively simple approach to the general subject of plasticizer polymer relationships which is becoming of increasing importance to the technologist in this field. It is hoped that additional workers will be encouraged to carry out experimentation along similar lines so that the importance of these concepts may be more fully utilized.

Acknowledgment:

It is a great pleasure to acknowledge the assistance of the staff of the Dielectrics Laboratory of Federal Telecommunication Laboratories, Inc., in making the various measurements reported, and the permission of the management to present this contribution.

The Need For Standardization of Industrial Diamond Products

A Suggested Standard for Industrial Diamonds and Tools; a System of Nomenclature

By H. L. Strauss, Jr.[1]

Up to this time standards for industrial diamonds have not been attempted, due to difficulties encountered when the subject is fully explored—such consideration as: (1) country of origin, (2) the many general quality groupings, (3) shapes, and (4) color and freedom from flaws. There are many subgroups and refinements thereof to further complicate this situation.

At this point one may ask, "Why the concern about industrial diamonds?" People have been using them for years and no one seems to have failed to r - ceive knowledge that is theirs for the asking.

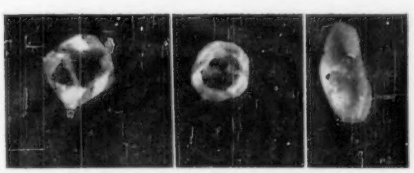

Fig. 1 Fig. 2 Fig. 3

Fig. 1.—Octahedron Shape.
Fig. 2.—Blocky Shape.
Fig. 3.—Elongated Shape.

The same might be said of many things. For example, people used turned threads before precision ground threads were employed, and organizations have met to provide the necessary thread standards which guide a producer today as to acceptable standards of tolerance. These specifications have been a boon to every industry making or using threaded devices. A similar boon to industry could take form in the general acceptance of standards for industrial diamond products.

Industrial diamonds today represent a commodity of utmost importance. They are classed by the Government as a strategic mineral commodity, necessary to peacetime and wartime production. Therefore, they are stockpiled for use in time of need.

One of the contributing factors to the need for standardized control and careful use is the unfortunate fact that they are not mined in this country. Since industrialists in this country depend on foreign powers for an uninterrupted supply of industrial diamonds, purchasing diamonds according to standards is important to our national security.

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[1] National Diamond Hone & Wheel Co., New York, N. Y.

Importance to Manufacturers:

The user naturally, if he had the knowledge, would attempt to set up some standards as to shape, size, color, and allowable flaws. But even before setting up standards, a generally acceptable nomenclature would have to be devised. An attempt has been made to do this as a first step in establishing standards. Before any intelligent discussion can take place, one must know what the other man is discussing and *vice versa*. Therefore, the following tentative suggestions for the standardization of industrial diamond nomenclature and classification have been developed.

Suggested Definitions and Classification According to Physical Shape

Type I—Octahedron Shape:

Usually a diamond having a symmetrical shape with an equidistant apex culminating in a pointed diamond (see Fig. 1). The points or corners may be somewhat rounded, the amount of imperfection allowable being dependent on the use.

Grade 1. Octahedron Shape (usage—wheel dressing tools).—Should be free from flaws or cracks and have a transparent color, allowing light to be reflected and permitting close inspection.

Grade 2. Octahedron Shapes.—Should have no cracks, but may have flaws or carbon spots located internally but not near wear points; color transparent to translucent.

Grade 3. Octahedron Shapes.—Having obvious flaws or a crack in a part of the stone not adjacent to a wear point. Having internal flaws and surface flaws on three or more corners, and possibly one or two good wear points. The color is translucent to transparent.

Type Ia—Crystal Type Octahedrons:

"Crystals," as they are called in the trade, are similar to octahedrons, except for their size and surface condition.

Suggested Standard Definition (for use in thread grinding practice only): A crystal is an octahedron whose surface is both smooth and without defect. The corners or points are sharp, and if intended for thread grinding, the radius at the apex does not exceed 0.003 in.

Grades are similar to those as given for octahedrons.

Type II—Blocky, Ill-defined Shapes:

This type of diamond is used for wheel dressing. As shown in Fig. 2, these stones may have from one to four corners and usually are not of any definite shape.

Grade standards are similar to the octahedron designation.

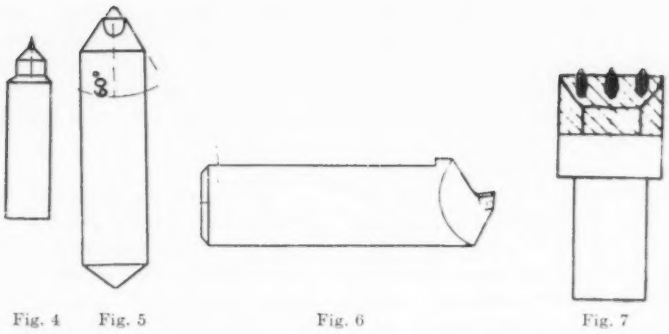

Fig. 4 Fig. 5 Fig. 6 Fig. 7

Fig. 4.—Radius Dressing Tool.

Fig. 5.—Thread Grinder.

Fig. 6.—Turning Tool.

Fig. 7.—Cluster Type Dresser.

Type III—Elongated Shapes (See Fig. 3):

Radius Dressing Tools.—A diamond whose length is three times its girth. (One grade only.) Has complete freedom from flaws or carbon spots on the extremities. Carbon spots internally at the center of the stone may be present.

Cluster Type Tools.—A diamond whose length is about twice its girth.

Grade 1: Stones whose lengths are two or more times the girth. Minor flaws and larger spots are permissible at any position on the expendable stone.

Grade 2: Stones whose length are twice the girth or less and ranging from translucent to opaque in color. Large carbon spots and flaws are permissible.

Crushings:

In addition to the above, "crushings" for use as diamond powder is a recognized article in the trade.

For use as "crushings," diamonds may be of any shape or color. The stones customarily have a shattered, laminated, or carbonaceous appearance.

Note.—The above partial list classifies the diamond as to physical types. Other classifications are used, such as by country of origin and by present trade names, but the above list indicates the need, for some group directly interested in the subject, to stimulate, propose, and undertake standardization.

The three countries supplying diamonds in greatest quantity are: (1) Belgian Congo, (2) Union of South Africa, and (3) Brazil. In many cases these three areas produce diamonds that have repetitious characteristic properties. For example, many diamonds originating from the Belgian Congo will have a coated or frosted characteristic appearance and possibly a cubical shape, whereas those diamonds found in South Africa have, in many cases, an octahedral, blocky, or elongated shape, with a smoother, more translucent appearance.

Classifications According to the Finished Tools

Tools are frequently referred to as "wheel dressers," "thread grinders," etc., and the following definitions are suggested:

Wheel Dressers.—The term "wheel dresser" should be applied to all diamond tools whose purpose is alteration of any form on a grinding wheel.

Straight Dressing Tools.—All tools used for purposes of straight line movement, known at present as ordinary wheel dressing tools. Diamonds may be octahedron or of blocky shape.

Radius Dressers.—Tools used to generate any concave, convex, angle, or any combination of the above (see Fig. 4).

Thread Grinders.—Tools containing a diamond (Fig. 5) used to generate a thread form on a grinding wheel. The diamond may be one of a variety of shapes, but in any event, it must be of first quality.

Diamond Turning Tools.—Diamonds specially polished or lapped, and used to turn metal (Fig. 6). The diamond must be of first quality.

Diamond Cluster Tools.—Multistone dressers of somewhat elongated shape (Fig. 7).

Industrial Diamond Wheels and Hones.—The terms apply to many types and bonds, such as (*a*) ceramic, (*b*) metal, and (*c*) resinoid, usually a compression molded phenolic binder with additives. (It is interesting to note the following standards are urgently needed for generally accepted bonds, particle sizes, and surface measurements, wherein the user can obtain some indication of wearability: (1) soft bonds of phenolic nature giving higher finish than a metallic bond, (2) particle size of diamond powder used, and (3) length of grinding or lapping surface.)

The above is meant only to be a sketchy outline of what is required as an aid in the purchasing and use of loose diamonds and diamond tools. It is presented by the author to elicit discussion. Comments and suggestions as to the proper approach to standardization would be appreciated, looking toward the formation of a discussion group.

Twenty to Thirty Years' Weathering of Asphalt Shingles Made with Unfilled Coatings*

By G. L. Oliensis[1]

SYNOPSIS

Laboratory and Weatherometer tests on asphalt coatings, such as used in ready-prepared roofings, have consistently pointed to the greater probable durability of the filled than the unfilled types. In 1946, however, it was shown for the first time that actual 10-yr. exposure tests on large panels of coating on saturated felt had failed to bear out this trend. The present paper presents additional corroborative evidence of a number of asphalt shingle roofs made with unfilled coating that have successfully weathered 20 to 30 yr.' exposure and therefore justify a reconsideration of such roofing specifications as make the use of filled coatings mandatory.

IN 1946, the author presented a paper at the annual meeting of the Society describing his observations during a 10-yr. period on a total of 24 square-foot panels of filled and unfilled coatings applied on saturated felts cemented to an old asphalt roof deck at Madison, Ill. Until these tests were started, the author had been a firm believer in the efficacy of filler in increasing the crack resistance and toughness of asphalt coating. This belief had been based, quite naturally, on literally hundreds of laboratory tests that had demonstrated convincingly: (1) that filler increased the resistance to cracking at 32 F. of 1-in. cylindrical molds of coating; (2) that filler increased the resistance of asphalt shingles to the shearing or stripping of their granules and coating in the so-called laboratory "slam," or "shatter," test; and (3) that filler increased the number of cycles before failure of layers of coating on small aluminum panels when subjected to the Weatherometer test.

When, therefore, the author's 24 large panels of filled and unfilled coatings on saturated felt exposed to actual weathering outdoors failed to reveal any such greater resistance to cracking on the part of the filled coatings, he was inclined at first to minimize the significance of his initial observations as being nonrepresentative or as having no necessary bearing on the ultimate results, since they seemed to run counter to years of methodically conducted laboratory testing.

It is therefore interesting to trace, in reviewing the successive reports he made from time to time on his observations on these panels, the slowly dawning realization that he was indeed witnessing a marked, but nevertheless, authentic and indisputable, contrast between laboratory tests and actual exposure tests; and that that contrast must signify either that unfilled coatings possessed a reserve of weather-endurance that those particular laboratory tests were inherently incapable of detecting, or that the toughening effect of filler on coating as indicated by laboratory tests had no particular relation to, or influence on, the more essential factor of the durability of asphalt roofings under actual weathering conditions.

GENERAL EVIDENCE ON DURABILITY OF UNFILLED-COATING ROOFINGS

Once having become reconciled to this new point of view, the latter did seem eminently reasonable after all; for to those familiar with the phenomenal growth of the asphalt roofing industry in the three decades before the general advent of filler in coating (between 1900 and the early 1930's), it would seem incredible that such a rapid growth of the industry from its small beginnings in 1900 to an output of approximately 40,000,000 squares in 1927 would have been possible with roofing made with the unfilled coating that was used exclusively during that period *if* unfilled coating in actual service were really as brittle and as prone to shattering, cracking and disintegration as laboratory tests had so consistently been demonstrating it to be.

However, more concrete evidence of the durability of roofings made with unfilled coatings is now available and the author presents this evidence herewith, based upon roofs in actual

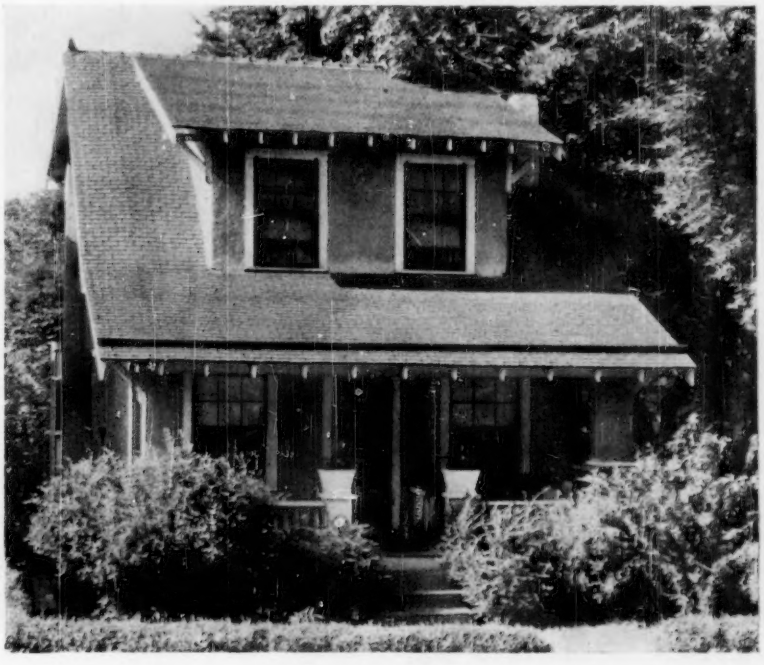

Fig. 1.—Roof A.

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* Presented at the Fifty-Second Annual Meeting, Am. Soc. Testing Mats., Atlantic City, N. J., June 27–July 1, 1949.

[1] Director of Research, Lloyd A. Fry Roofing Co., Summit, Ill.

TABLE I.

	Roof A	Roof B	Roof C	Roof D	Roof E	Roof F
Location of roof	Kansas City, Mo.	St. Louis, Mo.				Madison, Ill.
Street	.....	Bailey	Newstead	Rosalie	Carrie	Bissell
Type of strip	4-in-1	4-in-1	4-in-1	3-in-1	3-in-1	Individual
Size of shingle, in.	10 × 32	10 × 32	10 × 32	12 × 32	12 × 32	8 × 12¾
Inches exposed	4	4	4	5	5	4
Type of granule	Slate	Slate	Slate	Slate	Slate	Slate
Color of granule	Bl.-Blk.	Bl.-Blk.	Bl.-Blk.	Bl.-Blk.	Bl.-Blk.	Natural green
Back dusting	....	Very fine talc				
Thickness of felt	No. 50	No. 48	No. 48	No. 70	No. 70	No. 48
Approx. finished weight, lb. per 108 sq. ft.	82	84	84	110	110	84
Date applied	Feb., 1923	Spring, 1928	Spring, 1927	Spring, 1925	Spring, 1925	June, 1918
Age when photographed, yr.	23.3	20.7	21.7	23.7	23.7	30.5
Approx. area, squares	15	20	14	30	6	1
Approx. slope, in. per ft.	6, 3, 2	4	6, 3, 2	4	4	3½
Shaded	Yes	No	Yes	No	No	No
Asphalts Used						
Saturant:						
Penetration at 77 F. 100 g. per 5 sec.	....	25 to 30	25 to 30	25 to 30	25 to 30	25 to 30
Softening point (Ball and Ring)	....	150 to 160 F.	...		137 to 147 F.	
Soluble in CS_2, per cent	99.5+	99.5+	99.5+	99.5+	99.5+	99.5+
Coating:						
Penetration at 77 F. 100 g. per 5 sec.	....	18 to 22	18 to 22	16 to 20	16 to 20	18 to 23
Softening point (Ball and Ring)	....	215 to 225 F.	215 to 225 F.	210 to 220 F.	210 to 220 F.	210 to 225 F.
Soluble in CS_2, per cent	99.5+	94.5 to 97.5				99.5+
Added Filler	None	None	None	None	None	None
Analysis						
Test No.			S2399		S2398	S2400
Weight per 108 sq. ft., lb.:						
Felt			12.2		17.3	9.6
Saturant			20.2		31.1	15.3
Coating—face			(19.5)		(20.2)	(15.8)
Coating—back			(3.4)		(3.4)	(15.0)
Coating—total			22.9		23.6	30.8
Slate			14.0		35.3	22.7
Mineral matter on back (by ashing)			0.9		0.6	0.7
Total			70.2		107.9	79.1
Parts saturant			165		180	159
Extracted Felt:						
Weight per 480 sq. ft. (corrected for excess ash), lb.			54.4		76.8	42.9
Thickness, in.			0.064		0.095	0.048
Mineral Matter Passing No. 100 Sieve in "Coating Plus Passing No. 100 Sieve"						
Ash in inner portion of felt, per cent			7.98		8.5	6.95
Ash in whole felt, per cent			8.24		8.41	7.1
Weight of mineral matter passing No. 100 sieve, lb. per 108 sq. ft.:						
(a) Entrained in felt (calculated from felt ash)			0.04		0	0.02
(b) By washing total CS_2 insoluble through No. 100 sieve			1.79		1.34	1.48
Total			1.83		1.34	1.50
Total mineral matter passing No. 100 sieve (on basis of total coating plus mineral matter passing No. 100 sieve), per cent			7.4		5.4	4.7

service for from 21 to 31 yr., whose composition, age, location, and type of coating is authentically established. These roofs are six in number, one being the product of the American Asphalt Roof Corp., and the other five the output of the former Barber Asphalt Co. In Table I is given a tabulation of all the data available on these six roofs, which are identified as A, B, C, D, E, and F, respectively. One or more photographs of each of them are shown in Figs. 1 to 6, inclusive.

Description of 20 to 30-Yr.-Old Roofs

Roof A:

The author's attention was directed to this roof through an advertisement of the American Asphalt Roof Corp. in the 1948 issue of *Retail Lumberman* in which a cut of the roof was included, with the following caption:

"Would you guess this roof to be almost 25 years old? These . . . asphalt shingles were applied in February 1923! Here is an outstanding example of . . . wearability. After close to a quarter century of service, these blue-black, 4-in-1 strip shingles obviously are in excellent condition on the large, front area of this roof. On the south

East side. West side.

Fig. 2.—Roof B.

side of the house, where the roof is almost flat, the shingles are worn, yet still weathertight!"

The management of the American Asphalt Roof Corp. has kindly furnished the 7 by 9-in. photograph from which the cut had been made, and a reduced copy of this is shown, with permission, in Fig. 1.

The shingles on this roof are 4-in-1 strips of uniform thickness, exposed 4 in. to the weather.

An examination of the photograph with a magnifying glass indicates that with the exception of a small group of some eight or ten tabs (on the flatter front part of the roof immediately adjacent to the gravel stop) which have lost most or part of their coating, and a minor degree of decoating about a foot higher up, and a slight cocking up of the tabs here and there on the relatively flat dormer, which may be due solely to the blowing in of small twigs and leaf fragments from the large tree that brushes over that portion of the roof, the shingles as a whole substantially justify the favorable comments in the advertisement. The steeper areas of the roof seem to be in especially good condition.

West side.

The author had assumed from the first that since this roof was applied in 1923, long before filler began to be used extensively in the roofing industry, the coating in these shingles was no doubt unfilled. In order to eliminate any doubt he secured from the American Asphalt Roofing Corp. the following statement, dated March 29: "We are able definitely to tell you that there was no filler used in the coating."

Fortunately, we have a good deal of even more detailed information on the other five roofs B to F inclusive, discussed in Table I, since the shingles all came from the Madison plant of the old Barber Asphalt Co. and all but the earliest one of the five were manufactured while the author was chemist-in-charge at that plant, and as such had direct control of the formulas and characteristics of the saturants and coatings and of the makeup of all the roofings manufactured there. Inasmuch as his records and test data show that the use of fillers in the Barber Company's Shingle goods was not begun at Madison until October, 1932, there should be no doubt that all these shingles were made with unfilled coatings. This is, in fact, amply borne out, as will be shown later, by the analysis of the shingles taken from three of the five roofs, namely Roofs C, E, and F. While no samples have so far been obtainable of the shingles on roof D, they were of the same type and date of manufacture as those of roof E. The three analyses, therefore, really represent four of the five roofs, and the only one not covered is roof B, which is the youngest, and therefore not quite as significant for the purpose of this paper as are the other older four. A brief discussion of each of these roofs follows:

Roof B:

As just stated, this is the most recently applied of the five roofs. Its age when photographed last December was nearly 21 yr. It faces east and west and is not shaded by trees (or by adjoining buildings except partially on the west). The shingles are 4-in-1 square-butt, uniform-thickness strips, exposed 4 in. to the weather, and are all in excellent condition on both sides of the roof. The tabs are well sealed, lie flat and uncurled, show no blistering or cracking of the top layer of coating, or any wearing away at the lower corners or exfoliation of the felt at the exposed edges. To all intents and pur-

East side. West side. West side.

Fig. 3.—Roo C.

poses the roof seems practically as good as new.

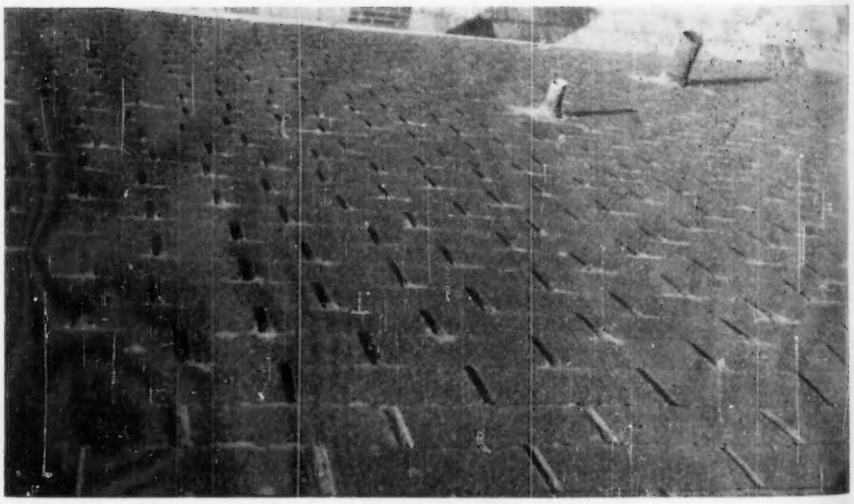
Roof C:

This roof was applied a year earlier than B and is consequently now over 22 yr. old. It faces east and west, and is covered with exactly the same type of 4-in-1 strips as roof B. Trees surround the house and their branches brush over the roof in spots and lash it in strong winds. Small twigs and fragments of leaves have become lodged under the tabs here and there and have slightly cocked up some of them. As a result, while the tabs as a whole are well sealed together, the edge areas of some of the tabs are slightly warped and the extreme corners are slightly worn. Some of the tabs show a number of very small areas of bare coating or felt, possibly as a result of occasional blisters that had broken. In spite of these minor defects, the tabs as a whole are all still sound and firm and rain-tight, and the author therefore still classifies the condition of this 22-yr.-old roof as definitely good.

Roofs D and E:

These two roofs were applied at about the same time, over 24 yr. ago. The larger roof, D, faces northwest and southeast while the smaller roof, E, over a garage faces northeast and southwest. Both are unshaded by trees or adjoining buildings. The shingles on both are 3-in-1 uniform-thickness strips, with cutouts $3\frac{3}{4}$ in. wide, based on No. 70 felt and laid 5 in. to the weather. About five years after the roofs were applied, a fine snow driven by a heavy wind apparently forced its way in under the tabs through the wide cutouts on roof D, and after thawing developed several small leaks. To prevent future leaking from that cause, dabs of plastic cement were applied at the top edge of these cutouts over the entire roof D. These dabs are still visible in Fig. 4. No further trouble has been experienced with either roof D or E. The shingles on these two roofs are in almost as perfect condition as those on the 21-yr.-old roof B. The tabs lie flat, snug, unwarped, unmarred by blisters or cracks, with practically no rounding at the corners or exfoliation of the felt at the edges. Both roofs are the finest examples of asphalt roof of their age that the author knows of. Roof D, over the garage, has frequently been pelted with rocks by the neighborhood youngsters playing in the adjoining alley and vacant lot. A few of these rocks are visible in the photograph, but as will be noted, there has been no consequent spalling of the top coating or any other ill effect from the impact of the rocks. This point is rather significant in view of the claim so often advanced, based on purely laboratory-conducted tests, that unfilled coatings shatter readily under impact.

Southeast side.



Northwest side.

Fig. 4.—Roof D.

Roof F:

This roof (or rather portion of roof, since it is only one square in size) is truly a "battle-scarred veteran," as it was applied in June, 1918, over 31 yr.

Southwest side. Northeast side.

Fig. 5.—Roof E.

ago, at the roofing plant of the former Barber Asphalt Co., in an attempt in those early days to determine just how long an asphalt shingle roof could be expected to last. It faces south, and is unshaded. The shingle is a simple old-style 8 by 12¾-in. individual type, of uniform thickness over-all like the other five in this group, and is laid approximately 4 in. to the weather. Though the nailing points were extraordinarily high, as much as 5¾ and 6 in. from the butt, the tabs soon sealed firmly together. For a time, these shingles were inspected each summer and winter to test their flexibility and the degree of adhesion between the tabs under varying temperature conditions. Occasionally small corners were broken off during these examinations. When it was realized that the prying up of the sealed tabs and their frequent handling might ultimately shorten the life of this square, inspections were made at progressively longer intervals. Until about ten years ago the shingles in this square remained in excellent condition. Thereafter, the roof deck on which this square had been applied began to be used more and more frequently as an exposure deck, because of its southern exposure and freedom from shade; and square F was therefore often tramped over and scuffed by men carrying bundles of shingles to various parts of the roof deck. Nevertheless the shingles still held out well until about three or four years ago when they began to deteriorate noticeably. At the present time, many of the exposed tabs in the lower half of the square feel rather brittle and lifeless and have become decoated along the sides and butt edges, and the felt thus exposed has become brown and worn away. However, the upper two-thirds of each shingle are still unimpaired and are so tightly sealed that they cannot be separated without mutilation. Hence this square though already 31 yr. old, is still rainproof and weathertight and serviceable, in spite of the rough handling it has received in both the earlier and later stages of its exposure.

Measured by any normal standard of durability, all these six roofs, ranging in age between 21 and 31 yr., rank extremely high. Their record is all the more significant when it is reflected that the last five roofs are not merely the best five that could be selected in support of the author's thesis, but are *all* the roofs applied prior to 1932 of which the author has personal knowledge; how many more such veteran roofs are still giving yeoman service one cannot say. The shingles of these six outstanding roofs were, as stated, without exception made both with *un*filled coating, as shown by the plant records in the case and by the corroborative analysis of the shingles from three of the roofs, a discussion of which follows.

Fine Mineral Matter Extracted from Shingles

The analysis of the three roofs just referred to shows that the percentage of mineral matter passing the No. 100 sieve, on the basis of the coating plus the material passing that sieve, ranges between 4.7 and 7.4. It is clear that much of this fine mineral matter must be material that is not incorporated in the actual coating—such as the approximately ½ lb. of fine talc dusting on the back and the fine dust either initially present in the slate granules or developed in them by attrition during the passage of the shingles through the squeeze rolls of the roofing machine and their subsequent storage and handling. Thus the shingle from roof E, which the plant records definitely show was made with a 99.5 per cent pure-bitumen coating, nevertheless reveals on analysis 4.7 per cent of mineral matter passing the No. 100 sieve, all of which could of course only have come from the back dusting and granules. Hence percentages of fine mineral matter on the order of 4.7 to 7.4 must be regarded as demonstrating both the use of *un*filled coating and the absence from the coating proper of more than purely nominal amounts of fine mineral matter passing the No. 100 sieve.

Nevertheless, even if we did assume for the sake of argument that all the fine mineral matter passing the No. 100 sieve was actually present as filler in the coating proper (which assumption is manifestly unjustified, as has just been explained), the question still remains as to whether even this larger amount of fine matter could be considered as responsible to any extent for an increased durability in the roofings from which it was extracted.

A good deal of data has been accumulated on this very subject both in the author's and other laboratories. It is well known that the first few small increments of any filler (except perhaps those of the more or less fibrous type, such as asbestos or actinolite or perhaps mica) have practically no effect on

Fig. 6.—Roof F.

any of the usual test properties of asphalt coating. Only when the filler percentage rises to 20 or 30 per cent are the characteristic effects of filler on coating noted, in the raising of the softening point, lowering of the penetration, and increase in resistance both to laboratory impact test at 32 F. and to cracking on aluminum panels in the weatherometer test; and it is only when the filler is 40 or 50 per cent that these effects, whatever their true significance may be, begin to grow really pronounced. Just what effect a content of only 5, 7.5, and 10 per cent of one of the usual fillers of a grading passing the No. 100 sieve will have on the tests of ordinary unfilled coating, is concretely illustrated in the following table:

Unfilled coating, per cent	100	95	95.5	90
Silica dust passing No. 100 sieve, per cent	0	5	7.5	10
	100	100	100.0	100
Characteristics (averages of 3 tests)				
Appearance of fracture	Glossy	Glossy	Glossy	Glossy
Penetration at 77 F. 100 g. per 5 sec.	19	19	19	19
Softening point (ball and ring), deg. Fahr.	222.3	224.2	224.3	225.3
Impact test at 32 F., cm. drop before fracture	14.3	15.3	15.3	14.0

The effect, it will be noted, is practically nil. When it is borne in mind, too, that the amount of filler, the roofing manufacturer usually does add to coating is large enough to impart to it a decidedly dull instead of glossy fracture, lowers its penetration about two points, and raises its softening point about 10 F. and its impact test about 50 per cent, it can be appreciated how little even 10 per cent of ordinary filler can serve to impart filled-coating characteristics to a coating; and consequently how much less the 4.7 to 7.4 per cent of fine material found on extraction could have affected the physical properties of the coatings in the shingles here analyzed—even if that amount had *all* been incorporated in the coating proper (which as previously shown could not possibly have been the case).

Conclusions

The following conclusions appear amply warranted by the foregoing considerations:

1. The analysis of the three shingles has fully corroborated the claim based on the author's plant records that the coating used in those shingles was unfilled, and the presence of 4.7 to 7.4 per cent mineral matter passing the No. 100 sieve is not inconsistent with that claim.

2. Coating containing up to 10 per cent of fine mineral matter passing the No. 100 sieve is still virtually an unfilled coating and will behave as such.

3. A specification sanctioning the use of 15 per cent of fine mineral matter passing the No. 100 sieve, inclusive of the fine dusting, actually sanctions a filled coating that may contain well under 10 per cent of incorporated filler and would therefore have virtually the characteristics of an unfilled coating.

4. Such a specification, if it also stipulates that only filled coating must be used, errs in two ways: (*a*) It is illogical and inconsistent, in that it sanctions the use of a nominally filled coating that essentially is, and behaves like, an unfilled coating, yet at the same time it specifically excludes unfilled coatings; (*b*) it is unjustifiably restrictive in that it specifically condemns the use of unfilled coatings such as have in many cases given upward of 30-yr. service.

5. The logical way to rectify such a specification would be to eliminate the mandatory requirement for the use of filler in coating and for any minimum amount of fine mineral matter in the finished roofing.

DISCUSSION

Mr. E. H. Berger.[1]—Mr. Oliensis' paper gives some very interesting data on the durability of six jobs of asphalt shingles that have been in service for from 20 to 30 years. Data of this kind should be of value to the roofing technologist as from them he should learn how to formulate products of better durability and to write specifications so that the general quality level is maintained and improved.

Mr. Oliensis has confined his discussions and conclusions solely to the presence or absence of mineral stabilizer (filler) in the coating asphalt. He recommends that the requirements for the use of mineral stabilizer in coating asphalt and for a minimum quantity of fine mineral matter in finished roofing should be eliminated from all A.S.T.M. roofing specifications. He also states that such requirements specifically condemn the use of unfilled coatings such as those that were used on the six jobs cited.

My observations on the behavior, under actual weather service conditions of commercial asphalt roofings, as well as experimental roofings of known composition, have resulted in the following conclusions:

1. Good asphalt roofings can be made both with and without the use of mineral stabilizer in the asphalt coating. However, when mineral stabilizer is employed, there is more latitude in the choice of asphalts which are suitable for the manufacture of roofings. Consequently, since 1936, it has been possible to produce asphalt shingles from asphalts locally available which will show much better performance in service on the Pacific and Gulf Coasts than roofings manufactured prior to that time.

2. The quality and durability of asphalt shingles are not due primarily to any one raw material or to any single factor in the manufacutring operation but to a combination of the following factors:

(*a*) Use of felt of uniform thickness, porosity, and formation.
(*b*) Use of the proper quantity of an asphalt saturant which will not age rapidly at roof temperatures, will not migrate from the felt, and which is compatible with the coating asphalt.
(*c*) Use of the optimum quantity of an asphalt coating of slow aging characteristics.
(*d*) Use of suitable mineral stabilizer in proper quanity in the asphalt coating.
(*e*) Nonporous granules of good grain shape and with a screen grading that will give surfacings which afford maximum protection to the asphalt coating.
(*f*) Good adhesion between granules and coating asphalt.
(*g*) Good fabrication so that the pores of the felt are adequately filled, so that the coating asphalt bonds well to the saturated felt, and so that the granules are oriented and applied in such a manner as to give maximum coverage to the coating asphalt.

3. Since 1926, research activity in the roofing industry has been quite extensive and the information developed has been applied in terms of the factors above enumerated to the improvement of asphalt shingles as well as to all other roofing products. These are the factors, rather than the question of whether or not mineral filler was used in the coating asphalt, which have in a large measure been responsible for the ever-

[1] Johns-Manville Corp., New York, N. Y.

growing public acceptance of asphalt roofings, as illustrated by the fact that the 40 million squares of roofing used in 1927 has grown in the ensuing period of 20 years to approximately 83 million squares of such products in 1947.

4. Many asphalt shingles made since 1936 without the use of mineral stabilizer in the coating are not behaving like the six old roofs reported in Mr. Oliensis' paper. Such shingles appear to be more susceptible to curling and to loss of coating and granules than those made during this period with mineral stabilized coating. The Barber Asphalt Co., which made the shingles for five of the six jobs reported upon, was always very careful about the type and quality of the asphalts that they selected for the manufacture of their shingles. Furthermore, they made every effort to saturate their felts as completely as possible with asphalts of low mobility at roof temperatures and to use coating asphalts of the most durable type available. The data on asphalts furnished by Mr. Oliensis appear to substantiate this. In my opinion this may account for the excellent condition of the shingles on these five jobs after exposure to the weather for a period of from 20 to 30 years.

MR. R. H. CUBBERLEY.[2]—The paper by Mr. Oliensis is very interesting, in a limited way, but I do not believe Society decisions should be based on such evidence. It is such a small sampling of the total industry that it hardly can be called sufficiently representative to form the basis for conclusions.

The overwhelming evidence of our industry exposure decks and of field surveys is that properly selected mineral stabilized coating will consistently produce modern roofing of better quality than can be manufactured in the same plants without stabilizer. There are exceptions to every rule and Mr. Oliensis has apparently found a few.

It is perfectly true that 10 or 15 per cent of many stabilizers will have no appreciable influence on weathering resistance, but it did seem logical originally to permit improved service to be achieved by incorporation of a relatively small percentage of highly efficient stabilizer, as well as a higher percentage of less efficient stabilizer.

For example, 10 or 15 per cent of some stabilizers are known to be helpful. Of course, it should not be the province of the Society to dictate formulation to the manufacturer, but rather to protect the consumer from gross inferiority. On this basis, it is unquestionably logical that the minimum was withdrawn, as we all know that acceptable service can, and has been, provided by unstabilized coating.

On the other hand, such action does not mean that many manufacturers will abandon claims of pre-eminence to their individual formulations based on well-organized, broad private investigations. This competitive spirit is healthy and to be commended.

MR. G. L. OLIENSIS (*author*).—I cannot agree with Mr. Cubberley's claim that the roofs I have described are exceptional and cannot be considered representative. It should be borne in mind that the shingles used on the six roofs covered by the paper, were manufactured by two different manufacturers from five different unfilled coatings and four different saturants. Each of the five lots originating in the Madison Plant was in every case taken *purely at random* from stock production during the years 1918, 1925, 1927, and 1928, an over-all period of ten years; and all five roofs were laid, not by regular skilled applicators, but by ordinary carpenters in the course of their routine activities. Finally, the five Madison-made roofs in question are the only ones whose entire history I happen to be familiar with and can personally vouch for; and I have not withheld from my paper any roof I am familiar with made during that period whose performance has been any poorer than that of these five. Now had one or two of the five roofs failed and the balance lasted, it would still have been true, according to the almost infallible law of averages, that at least a reasonable portion of the production of those years from the same plant must also have given good service. When, however, *every single one* of the five roofs gave such splendid performance, the conclusion is inescapable that since in that ten-year period hundreds of thousands of squares of similar roofing were manufactured at the same plant, at least a fairly respectable portion of those shingles must be giving satisfactory service to this very day.

Since writing my paper, furthermore, my attention has been called to quite a number of other roofs made with unfilled coatings prior to 1932 by other manufacturers than those already referred to, which are still giving satisfactory service in as widely separated territories as Michigan, South Carolina, and Texas.

Nor can I concede the implication in the second paragraph of Mr. Cubberley's discussion that the overwhelming evidence derived from exposure decks and field surveys proves that mineral-filled coatings will produce better quality roofing than will unfilled coatings. In the first place, it is significant that Mr. Cubberley does not actually make that claim in those very words; he refers only to "properly selected mineral stabilized coatings" as making better quality roofing; and he concedes also that there are differences between the results obtained by the more efficient and the less efficient fillers. In the second place, no accelerated tests, no weatherometer tests, no exposure deck tests, can be recognized as having the validity, the authority, of actual service performance such as detailed in my paper.

I am glad, therefore, to note Mr. Cubberley's statement that "we all know that acceptable service can, and has been, provided by unstabilized coating"—in other words, by unfilled coatings such as are typified by the six roofs covered in my paper.

And I am heartily in agreement with the general feeling of his concluding paragraph, for in a rapidly expanding industry like that of asphalt roofing, if untrammeled by unnecessarily restrictive specification requirements, a healthy competitive spirit is bound to serve as a steady stimulus to active research on the part of each member of that industry, and to persistent effort toward achieving ever-improving quality and durability.

I have noted with great care and attention Mr. Berger's discussion of the factors that determine the quality and durability of asphalt roofing. In so far as he stresses the importance of proper control and quality of each of the ingredients entering into the composition of the roofing, I concur with him wholeheartedly.

There is, however, a particular significance that I should like to point out in Mr. Berger's requirement for the "use of *suitable* mineral stabilizer in *proper quantity* in the asphalt coating" (the italics are mine); for it will be recalled that Mr. Cubberley too had vouched only for "*properly selected* mineral stabilized coatings," and had referred to the differences in effectiveness between more efficient and less efficient stabilizers, and to the negligible influence of 10 or 15 per cent of many stabilizers. This no doubt explains Mr. Berger's recommendation of suitable filler and of filler of the proper quantity. It follows too that not only would *un*suitable filler and *im*proper quantities of them impair the quality of the roofing, but such other irregularities as fluctuation in the ratio of filler to coating from time to time in the manufacturing process, or imperfect or nonuniform digestion of the filler by the coating, or incomplete elimination of the air and moisture entrained by the filler that would impart a porous or honeycombed structure to the filled coating layer—these and similar conditions are equally to be guarded against.

Once, however, it is admitted that

[2] Assistant Research Director, Research Laboratory, The Flintkote Co., Whippany, N. J.

lack of proper control of the filler in any of the foregoing respects may make substandard roofing, it follows that the use of *un*filled coating has the important *practical* advantage that should not be overlooked, namely, that since it contains no filler whatever, it is inherently free from the danger of impairment in quality through any of the irregularities in supervision or plant control of the filler and its manipulation that I have just listed.

However, in my present paper—as well as in the one I released in 1946 on "10 Years' Outdoor Exposure of Filled Asphalt Coatings on Saturated Felts"—I have deemed it unnecessary to enter into a discussion of the relative merits or durability of filled and unfilled coatings. For my primary object in these papers has been to correct the erroneous impression, gained mainly from arbitrary laboratory tests and relatively small-scale exposure tests, that unfilled coatings were somehow a "second-class" type of coating, and to show that unfilled coatings have made and can make high-grade roofing; and that for that reason specifications should not be written so as to exclude roofings made with unfilled coatings simply and solely because they contain no filler when in all other respects they have been properly and carefully prepared in accordance with the best practice in the roofing industry.

I am happy to note that on this point both Mr. Cubberley and Mr. Berger seem definitely to agree with me.

Mixing and Sampling with Special Reference to Multi-Sized Granular Material[1]

By David Buslik[2]

SYNOPSIS

A formula is derived for the standard deviation of the per cent of a given size in random samples from a granular material with a known size distribution. This equation is compared with one previously reported which has been used as a basis for size sampling specifications by a test with random numbers. It is shown to be applicable to the study of the mixing of multi-sized material. A discussion of the mixing operation from the statistical point of view is presented to clarify the application of this equation in such studies. The arrangement of particles in a well-mixed aggregate of multi-sized material is discussed. It is shown that with such mixing under certain conditions the mode of packing of the pieces might be determined by applying the proposed equation to sampling data. It is also shown that the equation may be applied to the determination of the average size of an individual void in such an aggregate as concrete and as a quantitative test for segregation.

IN SAMPLING granular material to determine its size distribution, the problem arises as to the size of sample that should be taken to obtain results within a prescribed sampling error. One object of this paper is to present a formula for random samples from a multi-sized aggregate (Sections I and II, Eqs. 3 and 3*a*). Consideration is also given to the manner of arrangement of particles in such an aggregate (Section IV). This has entailed a discussion of mixing principles (Section III). It is shown that the formula derived in this paper may be used to study the mixing of multi-sized aggregates (Section IV).

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 1916 Race St., Philadelphia, Pa.

[1] Presented before the Division of Industrial and Engineering Chemistry at the 113th Meeting of the American Chemical Society, Chicago, Ill. The material of this paper has also been used as the basis of a dissertation by the writer in partial fulfillment of the requirements for the degree of M.S. at the University of Pittsburgh, Pittsburgh, Pa. Published by permission of the Director, Bureau of Mines, U. S. Department of the Interior.

[2] Chemical Engineer, Explosives Branch, Bureau of Mines, Pittsburgh, Pa. Present address, 7550 Gilbert St., Philadelphia, Pa.

I. THE STANDARD DEVIATION OF RANDOM SAMPLES

It is common practice to estimate the percentage of a given constituent in a mixture by means of random samples. If the particles or pieces composing the mixture are of uniform size, the standard deviation of the theoretical distribution of the estimates can be predicted by a well-known formula from probability theory (the standard deviation of the binomial distribution). Consider, for instance, a mixture of G per cent green balls and $(100-G)$ per cent balls differing from the green balls only in color. If the samples consist of a constant number, n, of balls, the equation is:

$$\sigma^2 = \frac{G(100 - G)}{n} \quad \ldots\ldots (1)$$

where σ = standard deviation of per cent green balls in these samples.

Manning (1)[3] has developed a theory that is used as a basis for size sampling specifications by the British Standards Institution (2). Equation 1 was written by Manning in the form:

[3] The boldface numbers in parentheses refer to the list of references appended to this paper.

$$\sigma^2 = \frac{G(100 - G)w}{W} \quad \ldots\ldots (1a)$$

where:

w = weight per piece, and
W = weight of sample.

This is strictly correct if w and W are constant as W/w will then equal n (constant). He then suggests that if a multi-sized aggregate is divided into two size fractions, Eq. 1*a* would give the standard deviation in the percentage by weight of the larger particles, in samples of weight W (assumed constant), where w is assumed to be the average weight of particle in the larger particle-size fraction. To determine the standard deviation of per cent of an intermediate fraction (say the 1-in. to 2-in. fraction in a 0-in. to 3-in. coal), Manning used Eq. 1*a* to determine the standard deviations σ_1 of the 2-in. to 3-in. fraction and σ_{1+2} of the 1-in. to 3-in. fraction and then determined the standard deviation, σ_2, of the 1-in. to 2-in. fraction by means of:

$$\sigma_2^2 = \sigma_1^2 + \sigma_{1+2}^2 * \quad \ldots\ldots (2)$$

* There is an obvious typographical error in the equation as printed on p. 49 of British standard 1293:1946.

It will be shown below that the procedure used by Manning is not applicable to random samples.

The following equation has been derived for the standard deviation, σ_ϱ, of the percentage of any size, w_ϱ, in random samples of constant weight, W, from any given size distribution (see Appendix for derivation).

$$\sigma_\varrho^2 = \frac{G(100 - G)\bar{w}_\varrho + G^2(\bar{w} - \bar{w}_\varrho)}{W} \quad \ldots\ldots (3)$$

where:

$\bar{w}_\varrho$ = average weight per piece of the size being investigated. This size will generally contain

range of sizes (say, 1-in. to 1½-in.) but will be called the w_g size. The method of computing the average weight of piece for this range, to use in Eq. 3, is given below in the discussion of Eq. 3*a*.

G = per cent by weight of aggregate which has size w_g.

$\bar{w}$ = average weight of all the pieces of all sizes in the entire mixture. It is defined by

$$\bar{w} = \frac{1}{100}(Aw_a + Bw_b + \ldots + Gw_g + \ldots)$$

where A, B, C, ... are the percentages by weight of the sizes w_a, w_b, w_c ... in the aggregate.

This equation applies only if the sizes composing the mixture are of substantially constant density.

To compare Eqs. 1*a* and 2 with Eq. 3, a sampling was made from an artificial aggregate known to be random. This was obtained from the Tippett table of random numbers (**3**). In this table the various digits 0 to 9 are arranged at random in groups of 4; this grouping was disregarded, as it had no application to the problem. The digit 1 was considered as representing a particle of weight equal to 1 unit, the digit 2 a particle of weight equal to 2 units, etc. The digit 0 was added as though it were a particle of weight equal to 10 units.

Samples were taken by running along horizontal rows, from left to right, adding digits until a sum of at least 95 was reached. They were terminated at this weight, so that the average weight of a sample would be approximately 100. It is realized that stopping at 97 would have approximated 100 somewhat more closely, but the general result would have been unchanged. The first sample was started on page 1, row 1, column 1, and terminated in column 18 of the same page and row. After enough digits had been added to make the first sample, the next digit was used to start the second sample. One hundred samples were collected. The samples terminated on page 2, row 7, column 28. The average weight of sample was 98.1.

In each sample the number of digits of each kind and the per cent by weight of each digit were computed. For instance, sample No. 1 was composed of one 1, four 2's, etc. The total weight of this sample was 101. Consequently the percentage by weight of number 1 weights or digits was 0.99 and of number 2 digits was 7.92 in this sample. The standard deviation of per cent of the various digits was determined by dividing the sum of the squares of the deviations from the average, by the number of samples.

In Table I the standard deviations determined experimentally are compared with values predicted by Manning's method (Eqs. 1*a* and 2) and by Eq. 3. It is clear from the results that Eqs. 1*a* and 2 do not apply to random samples. Despite this the application of Eqs. 1*a* and 2 appeared to give good agreement with data (see Table II) from a coal-sampling experiment (**1**) which indicates that the coal samples must have been nonrandom.

TABLE I.—COMPARISON OF STANDARD DEVIATIONS.

Digit	Experimental Standard Deviation, s_g	Standard Deviation Predicted by Manning's Equations, σ^*_g	Standard Deviation Predicted by Eq. 3, σ_g
1....	1.73	3.58	1.56
2....	2.99	7.13	2.91
3....	4.12	10.47	4.02
4....	5.62	13.76	5.52
5....	6.42	16.75	6.52
6....	8.50	19.20	7.72
7....	9.04	20.86	9.06
8....	10.66	21.22	9.60
9....	11.60	19.35	11.33
0*a*...	12.03	12.42	11.98

a Zero represents the number *10*.

II. Standard Deviation of Percentage of Sizes

As was mentioned, Eq. 3 above applies strictly if the various sizes composing the mixtures have the same density. In cases where the density differs, as in concrete, the volume of sample rather than its weight would be maintained constant. For such mixtures the following equation is written (see Appendix).

$$\sigma_g^2 = \frac{G(100 - G)\bar{v}_g + G^2(\bar{v} - \bar{v}_g)}{V} \quad \ldots (3a)$$

where:

V = volume of solid material in each sample (assumed constant),

$\bar{v}_g$ = average volume per piece of the size v_g being investigated,

G = per cent by volume of aggregate which has size v_g,

σ_g = standard deviation of per cent of size v_g in random samples of constant volume, V, and

$\bar{v}$ = average volume of piece in the mixture. It is defined by an equation analogous to that for $\bar{w}$ above, namely

$$\bar{v} = \frac{1}{100}(Av_a + Bv_b + Cv_c + \ldots + Gv_g + \ldots)$$

where A, B, C ... are the percentages by volume of the sizes v_a, v_b, v_c ... in the aggregate.

Aggregates occurring in industry do not usually contain a limited number of sharply defined sizes. Generally the sizes which occur vary continuously from the smallest to the largest. However, specifications for size generally consider a range of sizes, for example, 1-in. to 1½-in., as if it were a single size. It is shown in the Appendix that Eqs. 3 and 3*a* apply to such cases. That is, σ_g will give the standard deviation of percentage of a fraction containing a range of sizes.

The value of $\bar{w}_g$ to use in Eq. 3 is determined in the following manner. Let the G per cent of w_g — size pieces be further analyzed by closer sizing into

G_1 per cent of w_{g1} pieces, G_2 per cent of w_{g2} pieces, ... G_n per cent of w_{gn} pieces, where $w_{g1}, w_{g2}, \ldots w_{gn}$ are the various sizes comprising the w_g-size, and $G_1 + G_2 + \ldots + G_n = G$

Then

$$\bar{w}_g = \frac{G_1w_{g1} + G_2w_{g2} + G_3w_{g3} + \ldots + G_nw_{gn}}{G}$$

The quantity $\bar{w}_g$ can be evaluated from the above expression as precisely as desired, or by integrating some distribution law (for example, the Rosin-Rammler law (**4**)) that the sizes are known to follow. The quantities $\bar{w}$ or $\bar{v}_g$ and $\bar{v}$ (used in Eq. 3*a*) can be evaluated in similar fashion. An example is given in Fig. 8 of the Appendix.

A sampling scoop is never solidly filled, and there are always voids in the sample. Consequently when using Eq. 3*a*, the volume of the scoop should be corrected for the void space. Small variations in V due to changes in porosity in the different samples will probably not introduce large errors. As is shown below, small deviations from constancy of sample size do not cause marked deviations from the theoretical values of the standard deviation.

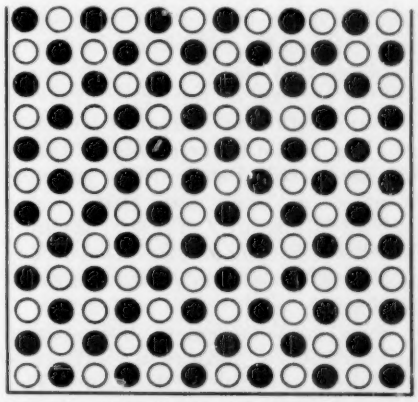


Fig. 1.—Completely Ordered Arrangement of 50 per cent Black and 50 per cent White Balls.

The general random sample from a multi-sized aggregate will not be both random and of a constant size, because the last piece, if chosen at random, will not usually bring the sample to exactly the required constant size. Eqs. 3 and 3*a* will give an exact solution only if applied to those random samples which by chance happen to have the fixed size (W or V). If the equations are applied

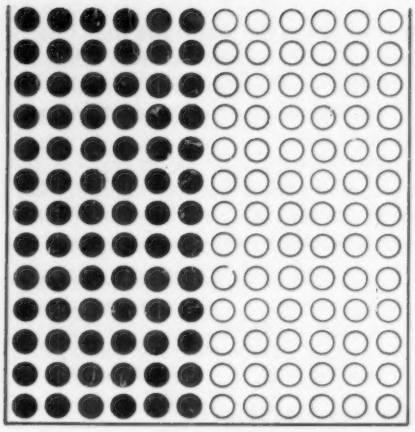


Fig. 2.—Completely Segregated Arrangement of 50 per cent Black and 50 per cent White Balls.

to all the samples as was done in the experiment cited in Table I, the results are approximate. The error introduced, however, would be small because practical samples (for size) will generally be much larger than any single piece and the size of the samples will be approximately constant. In the test described above, the small ratio of sample weight to weight of the largest "piece" (about 10:1) furnished a severe test of the error resulting when Eq. 3 is applied to samples varying slightly in size. In this test the sample weights varied from 95 to 104. Nevertheless the experimental results agreed well with the theoretical.

III. Mixing of Uniformly Sized Material

One of the possible applications of Eq. 3 is in the study of mixing of multisized aggregates. Published literature indicates that there is some vagueness on the subject of mixing. However, the application of statistical concepts can help to clarify the problem. Lacey (5) has described some of the arrangements of uniformly sized particles occurring in mixtures. He used the uniformity of samples and the standard deviation as a criterion of the degree of mixing.

Some consideration of the limiting arrangements of particles in a mixture is considered advisable at this point. The extremes are obviously a completely ordered arrangement such as is illustrated in Fig. 1 and a completely segregated arrangement of which an example is shown in Fig. 2. Since a random arrangement of uniformly sized particles is the best (from the point of view of mixing) obtainable from a practical mixer, it may also be considered a limiting arrangement. It may be defined as the arrangement in which the position of each particle is determined by chance. Hence the term "random" does not describe as specific an arrangement as do either of the two illustrated. The term rather describes the way in which the arrangement was achieved. Strictly speaking, no illustration of such an arrangement can be given; any single arrangement shown would have as little likelihood of being attained by random arrangement as any other which might be pictured.

Fortunately a knowledge of the exact arrangement that results when the particles are arranged at random is never essential. What is important is the uniformity of regions within the material or of samples withdrawn. In the case of a random arrangement, the uniformity is completely defined, as will be shown below, by the value of the standard deviation of the per cent of the sampled ingredient.

The distribution curves, Figs. 3 to 5, show that the uniformity of samples can be expressed quantitatively. These curves are formed by plotting in increasing order the percentage of black balls in a large number of samples from the limiting arrangements discussed above.

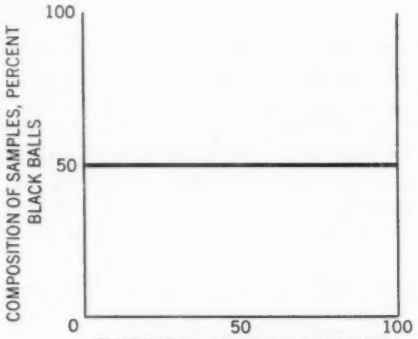


Fig. 3.—Distribution Curve for Samples from Arrangement of Fig. 1.

Figure 3 is a distribution curve for samples containing an even number of particles from the arrangement of Fig. 1. These samples are assumed to be a group with a rectangular boundary to simulate for practical purposes the approximately prismatic shape of sample usually obtained in industrial practice when sampling with a scoop. No matter how small these samples are, each will represent the composition of the mixture perfectly. Consequently the uniformity of such samples is perfect, and the standard deviation of percentage of black in samples from such an arrangement equals zero. With any arrangement a tendency to orderliness will tend to diminish the standard deviation.

Figure 4 is a distribution curve for similar samples from the arrangement of Fig. 2 for samples very small relative to the entire population. In such a case samples from the interface between the two ingredients will occur infrequently

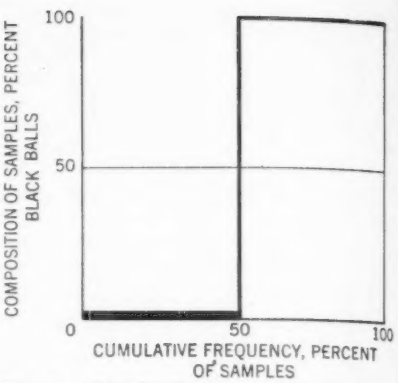


Fig. 4.—Distribution Curve for Samples from Arrangement of Fig. 2.

and were neglected in plotting Fig. 4. The curve shows that the samples have reached the acme of nonuniformity. If P = percentage of black balls in the mixture, and $(100-P)$ = percentage of white balls in the mixture, it is easily shown that for samples of any size (small relative to the population) from the arrangement of Fig. 2

$$\sigma = \sqrt{P(100 - P)}$$

where σ is the standard deviation of percentage of black balls in such samples. This represents the maximum value which σ can have. Moreover, in any arrangement a tendency toward segregation, such as is caused by incomplete mixing, will tend to increase σ.

The distribution curve for samples from a random arrangement containing about 25 or more particles is approximately given by the normal law of error which is plotted in Fig. 5. Tables of areas of the normal law can be found in technical handbooks. These will give the probability of any deviation from the mean composition. For instance these tables show that with a mixture of P per cent black and $(100-P)$ per cent white balls, the percentage of samples which contain between $(P-\sigma)$ per cent and $(P+\sigma)$ per cent black is 84.1−15.9, or 68.2, and between $(P - 2\sigma)$ and $(P + 2\sigma)$ per cent black is 95.5.

It is generally realized that, to improve the mixing of solids, it is advisable to decrease particle size. That the improvement can be measured quantitatively is not always realized. The following example is given which will also illustrate the use of the normal error law in describing uniformity of samples. The problem is to mix 15 per cent of powder A with 85 per cent of powder B so that 95.5 per cent of the samples of, say, 1 mg. will contain between 15 ± 1 per cent of powder A. Assume that both powders are reduced to the same size and they are thereafter randomly mixed. The preceding discussion has shown that 95.5 per cent of the samples will fall within the range

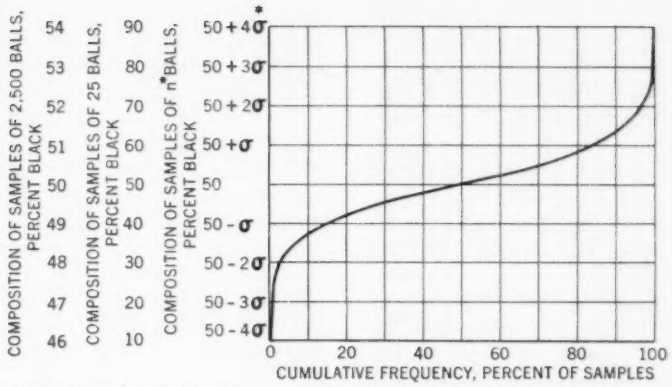


Fig. 5.—Distribution Curve for Samples from Random Arrangement of 50 per cent Black and 50 per cent White Balls—Normal Curve of Error.

* σ for any value of n can be computed by Eq. 1 of the text.

$(P - 2\sigma)$ to $(P + 2\sigma)$. Hence $2\sigma = 1$ and $\sigma = 0.5$.

Applying Eq. 1*a* for uniformly sized particles:

$$w = \frac{\sigma^2 W}{G(100 - G)} = \frac{0.25 \times 0.001}{15 \times 85} = 1.96 \times 10^{-7} g$$

which is the weight per particle required in order to obtain the desired uniformity.

The random arrangement is the only one of the three limiting arrangements in which σ or the uniformity of samples is affected by sample size. The increase of uniformity of samples with increase of sample size is shown by the curve of Fig. 5 for samples of 25 and 2500 balls.

Arrangements other than those previously described occur frequently and are of great practical interest. During the operation of a mixer, many such arrangements occur between the initial segregated arrangement and the final random arrangement. If there are differences in density, electrical charge, or particle size, the materials being mixed may not attain a random arrangement no matter how long they are agitated. In such cases the arrangement will generally be composed of regions of segregation dispersed throughout the material. Lacey (5) proposed an empirical mixing index for these "partial mixtures."

Under certain conditions of insufficient mixing, the experimental value of the standard deviation will give a physical picture of the type of arrangement. Suppose, for instance, that samples of weight W (constant) from a population composed of P per cent black balls and $(100-P)$ per cent white balls of weight w (constant) gave an experimental value for the standard deviation of per cent black balls, σ_{We}, and $\sigma_{We} = m \times \sigma_{Wr}$ (theoretical value of σ for random samples), or

$$\sigma_{We} = m \sqrt{\frac{P(100 - P)w}{W}}$$

where $m > 1$. Assume also that the following conditions are fulfilled: (*a*) That the agitation or mixing throughout the mass has been uniform so that the segregated regions are everywhere about the same size; and (*b*) That the size of regions is small relative to the size of the samples—so that the effect of splitting the regions by the samples may be neglected.

One could then infer that the black and white balls were arranged on the average in segregations of m^2 particles each and that these segregations in turn were randomly arranged. A check on the validity of this inference would be to determine whether σ^2_{We}, varied inversely with W as it would if the regions of segregation were arranged at random. The uniformity of samples from this arrangement could be determined from tables of areas of the normal curve by the method described above.

IV. Arrangement of Multi-Sized Aggregates

Brown (6) has discussed the modes of packing of mixtures of broken solids of varying size and density and the segregated arrangements occurring during the piling or vibrating of beds of such material. He considered a dense packing of small particles in the interspaces of large particles to be characteristic of a "uniform" mixture. In such arrangements, however, the small particles are segregated to a certain extent. To differentiate between these segregations and the gross segregations mentioned above, the latter might be called macrosegregations. The segregations of small particles of similar size in the "uniform" mixture could be termed microsegregations. It is thus obvious that the best arrangement obtainable with mixtures of sizes is not always a random one as with uniformly sized material. In general the ideal arrangement would seem to be a random arrangement of the large particles with microsegregations of the small particles in the void spaces. The size of the microsegregations would depend upon the size of the void spaces. The arrangement of the small sizes in such a case is thus analogous to that in the insufficiently agitated mixture of uniformly sized materials described above.

A partial check on the arrangement in presumably well-mixed aggregates has been made for conformity with the above hypothesis. This was done by comparing values of the standard deviation obtained from available sampling data with results predicted by Eq. 3. As an example, data from Manning's paper (1) is summarized in Table II. The data agree well with values predicted by his method (last column). These data were obtained from determinations on 21 samples screened to five sizes from a bulk of coal. The average weight of sample was given as 130 lb. and the average weight of particles of the largest size ($> 2\frac{1}{4}$ in.) as 0.375 lb. The average weight of piece for the other fractions was not determined but was estimated from the sieve sizes to be approximately 0.18, 0.08, and 0.01 lb., respectively.

TABLE II.—COMPARISON OF STANDARD DEVIATIONS IN TESTS ON COAL.

Size, in.	Mean Percentage from 21 Samples	Observed Standard Deviation, s_g	Calculated Standard Deviation by Eq. 3, σ_g	Calculated Standard Deviation by Eqs. 1*a* and 2, σ^*_g
$>2\frac{1}{4}$	4.6	1.19	1.11	1.13
$1\frac{3}{4}$ to $2\frac{1}{4}$	36.3	2.28	1.62	2.19
$1\frac{1}{4}$ to $1\frac{3}{4}$	52.9	1.91	1.58	2.01
$\frac{1}{4}$ to $1\frac{1}{4}$	5.6	0.73	0.26	0.71

The observed standard deviation for the largest size ($> 2\frac{1}{4}$ in.) agrees well enough with the value predicted by Eq. 3 to indicate that probably this size was approximately randomly arranged in the aggregate. However the experimental standard deviation for the smallest size ($\frac{1}{4}$ in. to $1\frac{1}{4}$ in.) differs enough from the theoretical random value to definitely indicate segregation. Both results are in accord with the assumed type of arrangement described above.

According to DallaValle (7) there is a need for methods of statistical analysis in the study of packing arrangements. Below a method is proposed which yields additional information concerning the mode of packing. It is first necessary to make two assumptions which are probably approximately true in well-mixed aggregates. These assumptions are:

1. The pieces of less than maximum size segregate in groups in the voids between the pieces of larger size and hence form microsegregations.

2. The microsegregations are randomly arranged in the aggregate.

In somewhat modified form the first assumption is rather generally accepted in the literature on concrete technology (**8, 9**) where it is assumed that the microsegregations of the smaller sizes fill the voids between the pieces of the next larger size. However, it is not necessary in this development to assume that the microsegregations fill the voids between the pieces of the next larger size only. In an actual packing there would be some indefiniteness about the boundaries of many of the microsegregations. Nevertheless there is a background of experience and experimental evidence (**8, 9, 10, 11**) attesting the existence of the assumed structure. This concept has been made the basis of specifications for the design of aggregate size compositions of maximum density (**11**).

Analysis of available data (Tables II and III) indicates that the largest size was at least approximately randomly arranged in the aggregates tested. Hence it seems reasonable to assume that the voids between them (and the microsegregations contained therein) were likewise randomly arranged. This is the justification for the second assumption above. As for the randomness of the voids between the smaller sizes, further information would be desirable. A method of testing is suggested below.

The results of the proposed method of analysis will give the average size of a microsegregation (number of pieces therein) for each size in the given aggregate. This information together with the assumed randomness of arrangement provide a more complete description of the mode of packing than has been available to date.

Computation of the number of pieces per microsegregation from the data of Table II was not satisfactory. The result for the number of pieces per microsegregation of the $1\frac{1}{4}$-in. to $1\frac{3}{4}$-in. size was negative. Such a result is, of course, meaningless. It may be due to a random sampling error in the value of the standard deviation for this size since a value of the standard deviation, determined by means of only 21 samples, is susceptible to large random sampling fluctuations. It can be shown by statistical methods that with this number of samples the probability of a random sampling error of 15 per cent or more in the value of the standard deviation is approximately one third. In fact, the procedure described below for determining the mode of packing will not work with the data of Manning unless one assumes that the experimental value of the standard deviation for the $1\frac{1}{4}$-in. to $1\frac{3}{4}$-in. size was affected by a large random sampling error of about 15 per cent.

To determine a mode of packing, calculations were made on data submitted by the National Sand and Gravel Assn. based on 204 samples from a $1\frac{1}{2}$-in. commercial gravel. The samples weighed approximately $27\frac{1}{2}$ lb. each. The average weight of piece in each size range was not reported but was estimated by sieving a river gravel available to the author and weighing about 500 pieces of each size. These values were used to calculate the theoretical values of the standard deviation for random samples from the gravel. Experimental and random values are compared in Table III.

TABLE III.—COMPARISON OF STANDARD DEVIATIONS IN TESTS ON GRAVEL.

Size, in.	Mean Percentage of Given Size from 204 Samples	Observed Standard Deviation s_g	Calculated Standard Deviation by Eq. 3, σ_g
$1\frac{1}{4}$ to 2	35.5	3.21	2.98
$\frac{3}{4}$ to $1\frac{1}{4}$	33.1	2.45	2.12
$\frac{1}{2}$ to $\frac{3}{4}$	15.4	2.08	1.09
$\frac{1}{4}$ to $\frac{1}{2}$	13.5	1.91	0.78

The agreement of the experimental standard deviation of per cent of the largest size with the values predicted by Eq. 3 in both sets of data (Tables II and III) indicates that this size was randomly arranged in both aggregates. The ratio of the experimental to random values tends to increase as the size of piece decreases. This indicates that the size of microsegregation (number of pieces therein) increases for the smaller sizes. This is exactly what one would expect.

The sum of the weights of all the pieces of like size in an average microsegregation may be defined as an equivalent weight of piece (w_g'). The number of pieces in an average microsegregation is then the equivalent weight of piece, w_g', for that size divided by the actual weight of piece, w_g. To determine w_g' for each size, Eq. 3 was written once for each size with w_g' as the unknown quantity. The experimental value of the standard deviation was substituted for σ_g and the mean per cent of each size for G, in these equations. The resulting four equations were solved simultaneously.

The results of these calculations on the data of Table III are tabulated in Table IV. It must be understood that the figures for number of pieces per microsegregation are average figures. Some of the individual pieces may be randomly arranged, and some of the microsegregations probably have considerably more than the average number of pieces. The value of 1.0 piece per microsegregation for the largest size is in agreement with the conclusion stated above that the pieces of this size were randomly arranged in the gravel. Since the equivalent weight of piece for each size is a function of all the G's and s_g's this result is not a necessary consequence of the previously noted agreement between σ_g and s_g for the largest size.

TABLE IV.—AVERAGE NUMBER OF PIECES PER MICROSEGREGATION IN $1\frac{1}{2}$ IN. COMMERCIAL GRAVEL.

Size, in.	Actual (Average) Weight of Piece, lb.	Equivalent Weight of Piece, lb.	Average Number of Pieces per Microsegregation
$1\frac{1}{4}$ to 2	0.15	0.15	1.0
$\frac{3}{4}$ to $1\frac{1}{4}$	0.042	0.052	1.2
$\frac{1}{2}$ to $\frac{3}{4}$	0.015	0.090	6.0
$\frac{1}{4}$ to $\frac{1}{2}$	0.0040	0.084	21

A confirmatory check on the validity of the assumption that the microsegregations were randomly arranged would be desirable. One method would be to determine whether s_g varied inversely as the square root of the sample weight. Data for such a check were not available, however.

The error due to screening was neglected in this analysis, as no data were available from which it could be estimated. However, the good agreement of s_g for the largest size with the value of σ_g calculated from Eq. 3 could be taken as an indication that the screening error was small. It is possible that the screening error might not be negligible with sieve analysis data from finer material due to the larger tolerances on fine sieves.[4]

V. Applications of Equations 3 or 3*a*

It has been shown that the arrangements of multi-sized material are very complex. In well-mixed aggregates the largest size or sizes are probably randomly arranged. Equations 3 or 3*a* may be used in setting sampling specifications for them such as (**2**). However, the smaller sizes are probably not randomly arranged in such mixtures. Sampling specifications for these would depend more on the void spaces between the larger particles than on the size of these small particles. Experience with a particular mixture might indicate a factor by which to multiply the value predicted by Eqs. 3 or 3*a* so as to determine suit-

[4] Standard Specifications for Sieves for Testing Purposes (E 11-39), 1949 Book of A.S.T.M. Standards, Part 2, p. 1015; Part 3, p. 1289; Part 4, p. 1165; Part 5, p. 1585; Part 6, p. 1221.

able sample sizes for these. The sampling specifications could be determined from the normal law of error by the methods given in the section on mixing. For writing scientific sampling specifications in mixtures with macrosegregations, some knowledge of the arrangement of the pieces is required.

Generally the size of sample required to attain a given standard of accuracy is determined by the weight of pieces in the larger sizes (Tables I and II). As these will be randomly-arranged in a well-mixed aggregate, Eqs. 3 or 3*a* may suffice for complete sampling specifications in such cases.

It was shown above how Eqs. 3 or 3*a* could be used to determine the mode of packing. If the sizes composing a mixture have the same density, the variations in weights of samples having a constant volume could be considered as due to a varying number of included void spaces. Application of the method used with the data of Table III would give the average size of a single void. However, there would probably be considerable experimental difficulty in maintaining the individual voids constant in volume from sample to sample. Any variations in void size in the various samples due to different packing densities would affect the results, since the variation in weights of sample would be assumed to be due to random variations in the number of voids of a given size.

Although the importance of avoiding segregation of concrete mixtures is generally recognized (12) there does not seem to be available a quantitative method of determining when segregation has occurred. However, by applying Eq. 3 to sampling data it should be possible to determine whether the largest size has segregated. To determine whether the smaller sizes have segregated (to form macrosegregations) more knowledge concerning the arrangements (size of microsegregations) in well-mixed aggregates will be required.

Acknowledgment:

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Appendix

Derivation of Equations 3 and 3*a*

Given a mixture of sizes having the size distribution defined below:

A = per cent by volume of size having volume v_a per piece,

B = per cent by volume of size having volume v_b per piece,

. . . . . .

G = per cent by volume of size having volume v_g per piece,

. . . . . .

M = per cent by volume of size having volume v_m per piece.

Let V = constant volume of solid material in the samples.

It is required to find the standard deviation, σ_g, in per cent of v_g size in random samples of volume V.

It will be helpful to consider first a specific example such as Fig. 6 which is a diagrammatic sketch of a random sample of multisized pieces, shown for convenience in two dimensions. In Fig. 7, the pieces are assembled to show the volume of solid material, which is constant for all the samples. In these diagrams, the volumes are represented as areas. For instance, the unit of area is taken as 1 sq. mm. and the volume, V, as 1600 units. The size of piece which is being investigated, v_g, has the size 6 units. Pieces of this size are shown blackened in the diagram. It is necessary to assume that the area of each piece shown in the diagram is an integral number of units. If the ratio of the areas is incommensurable, the error due to the fraction can be made arbitrarily small by taking the unit areas small enough.

If all samples are the same size, each could be represented, as in Fig. 7, by an area of 1600 units. In sampling for the pieces of 6 units size, each blackened unit area could be termed a success and each white one a failure. Each v_g piece then contributes 6 successes. A piece of any other size contributes a number of failures corresponding to its size. Thus a piece of 50 sq. mm. area contributes 50 failures.

In the general case, each sample of volume, V, is considered as broken into fictitious, uniform-size pieces of volume v_o which will henceforth be called units. Let the ratio of the size of a piece or of sample to these v_o pieces or units be given by:

$$a = \frac{v_a}{v_o},\ b = \frac{v_b}{v_o},\ \ldots\ g = \frac{v_g}{v_o},\ \ldots$$

$$m = \frac{v_m}{v_o},\ t = \frac{V}{v_o} \quad \ldots (4)$$

If v_o is taken small enough, a, b, . . . g, . . . m and t can be considered integers. This is the only requirement v_o must fulfill.

According to Eq. 4, each piece and each sample are composed of an integral number of units. Each sample is composed of t units. Each v_g piece is composed of g units, which are termed successes. The units composing any other size of piece are termed failures. Thus a v_m piece is

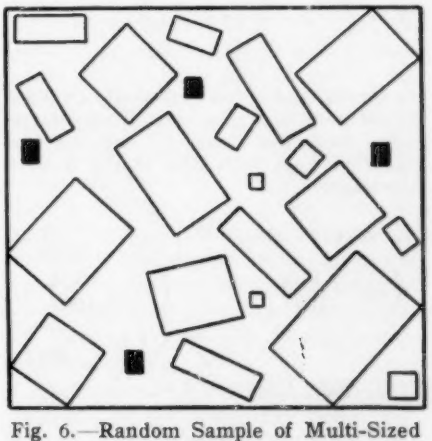


Fig. 6.—Random Sample of Multi-Sized Pieces.

Pieces of the size, 6 units (or sq. mm.), being investigated are shown blackened.

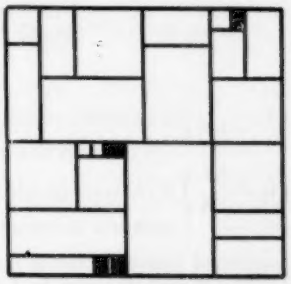


Fig. 7.—Pieces from Fig. 6 Assembled to Show Sample Size.

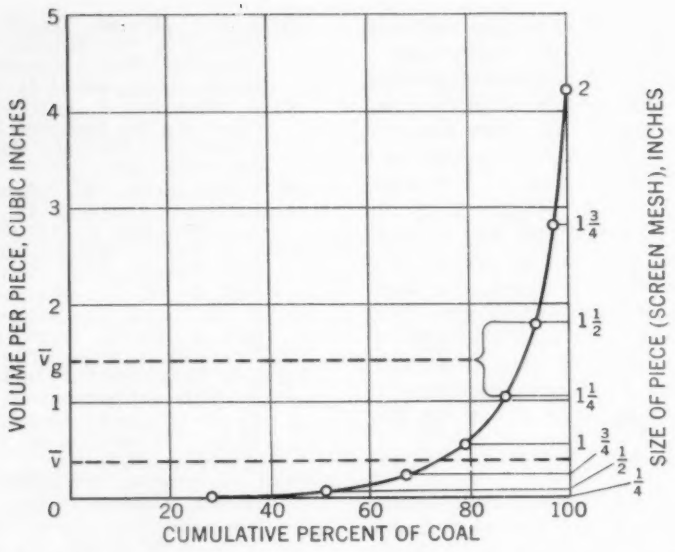


Fig. 8.—Calculation of $\bar{v}_g$ and $\bar{v}$ from the Size Distribution Curve of a 0 to 2-in. Coal.
Average volume of piece in the 1¾ to 1½-in. size range, $\bar{v}_g$. Also average height of curve between these two ordinates, $\bar{v}_g$.
Average volume of piece in the entire coal, $\bar{v}$. Also average height of the curve, $\bar{v}$.

composed of m failures. Let X_i = per cent by volume of v_g size in any sample, say, the ith. According to the concepts discussed above X_i will also equal $100/t$ (number of successes). Now let x_{ij} be a value assigned to the jth unit in the ith sample in the following manner:

$x_{ij} = 1$ if this unit is a success
$x_{ij} = 0$ if this unit is a failure

Then from the second statement of X_i above

$$X_i = \frac{100}{t}(x_{i1} + x_{i2} + \ldots + x_{ij} + \ldots + x_{it}) \ldots\ldots (5)$$

as the sum in Eq. 5 is equivalent to a count of the number of successes. To get deviations from the mean (G) subtract this quantity from both sides of Eq. 5, with the result:

$$D_i = X_i - G = \frac{100}{t}\left[\left(x_{i1} - \frac{G}{100}\right) + \left(x_{i2} - \frac{G}{100}\right) + \ldots + \left(x_{ij} - \frac{G}{100}\right) + \ldots + \left(x_{it} - \frac{G}{100}\right)\right]$$

$$D_i = \frac{100}{t}[d_{i1} + d_{i2} + \ldots + d_{ij} + \ldots + d_{it}] \ldots (6)$$

where:

D_i = deviation of per cent v_g from the mean (or G) in the ith sample

and

$d_{ij} = \left(1 - \frac{G}{100}\right)$ if the corresponding unit is a success

$d_{ij} = \left(0 - \frac{G}{100}\right)$ if the corresponding unit is a failure..... (7)

The square of many D_i terms must be averaged to compute the standard deviation. Hence if a large number (N) of samples are taken and σ_g is the standard deviation of per cent v_g in these samples

$$\sigma_g^2 = \frac{1}{N}\sum_{i=1}^{N} D_i^2 = \frac{1}{N}\left(\frac{100}{t}\right)^2 \sum_{i=1}^{N}[d_{i1} + d_{i2} + \ldots + d_{it}]^2 \ldots (8)$$

Expanding the quantity on the right of Eq. 8 will yield square terms and cross-product terms which are separated in Eq. 9 below:

$$\sigma_g^2 = \frac{1}{N}\left(\frac{100}{t}\right)^2 \sum_{i=1}^{N}[d_{i1}^2 + d_{i2}^2 + \ldots + d_{it}^2] + \frac{2}{N}\left(\frac{100}{t}\right)^2 \sum_{i=1}^{N}[d_{i1}d_{i2} + d_{i1}d_{i3} + \ldots + d_{i1}d_{it} + \ldots + d_{it}d_{it}] \ldots\ldots (9)$$

The problem is now to evaluate the quantities within brackets in Eq. 9 in terms of the size distribution and the volume of sample.

The bracket containing square terms is easily evaluated. From N samples there will result Nt square terms. If the number N is very large, the number of v_g units which come from v_g pieces (successes) will be close to $GNt/100$ and the number of failures must be close to $\frac{(100 - G)Nt}{100}$. The corresponding values of d_{ij} are given by Eqs. 7. Hence:

$$\frac{1}{N}\left(\frac{100}{t}\right)^2 \sum_{1}^{N}[d_{i1}^2 + d_{i2}^2 + \ldots + d_{it}^2] = \frac{1}{N}\left(\frac{100}{t}\right)^2\left[\frac{GNt}{100}\left(1 - \frac{G}{100}\right)^2 + \frac{(100 - G)Nt}{100}\left(\frac{G}{100}\right)^2\right] = \frac{G(100 - G)}{t} = \frac{G(100v_o - Gv_o)}{V} \ldots (10)$$

The last step results from the substitution of V/v_o for t.

To evaluate the cross-products $d_{ij}d_{ik}$, we can divide them into two groups:

1. Those in which the two units or v_g pieces come from different pieces—external cross-products.

2. Those in which the two units or v_g pieces come from the same piece—internal cross-products.

External cross-products:

The jth unit and the kth unit in these products are independent variables by hypothesis. Hence, the mean value of the product $d_{ij}d_{ik}$ is equal to the product of the mean values of d_{ij} and d_{ik}. This follows from a theorem in probability theory (**13**) which states that "the mathematical expectation of the product xy of two independent variables x and y is equal to the product of their expectations." From their definition it is seen that the mean values of d_{ij} and d_{ik} are zero. Hence the mean value of the product $d_{ij}d_{ik}$ is zero. It follows that

$$\frac{2(100)^2}{Nt^2}[\text{sum of all external cross-products}] = 0$$

Internal cross-products:

In the N samples the number of v_g pieces is nearly $\frac{GNt}{g100}$, and of v_h pieces is nearly $\frac{HNt}{h100}$, etc. Also each v_g piece will contribute $g(g - 1)$ internal cross-products, each of which will have the value $\left(1 - \frac{G}{100}\right)^2$ since both units in such a product are successes. Each v_h piece (where a v_h piece is any size other than a v_g size) will contribute $h(h - 1)$ internal cross-products, each of which will have the value $G^2/(100)^2$ since both units in such a product are failures.

Hence the second term on the right of Eq. 9 can be evaluated as follows:

$$\frac{2}{N}\left(\frac{100}{t}\right)^2 \sum^{N}[d_{i1}d_{i2} + d_{i1}d_{i3} + \ldots + d_{i1}d_{it} + \ldots + d_{it}d_{it}] = \frac{1}{N}\left(\frac{100}{t}\right)^2 \frac{Nt}{100}\left\{\left[\frac{A}{a}a(a-1) + \frac{B}{b}b(b-1) + \ldots + \frac{G}{g}g(g-1) + \ldots + \frac{M}{m}m(m-1)\right]\frac{G^2}{(100)^2} + \left[\frac{G}{g}g(g-1)\frac{(100)(100 - 2G)}{(100)^2}\right]\right\} = \frac{1}{V}[G^2\bar{v} + G^2v_o - 2G^2v_g + 100Gv_g - 100Gv_o] \ldots (11)$$

where:

$$100\bar{v} = Av_a + Bv_b + \ldots + Gv_g + \ldots \ldots\ldots\ldots\ldots\ldots\ldots (12)$$

Substituting from Eqs. 10 and 11 into Eq. 9, there results an equation similar to 3*a* of the text:

$$\sigma_g^2 = \frac{G(100 - G)v_g + G^2(\bar{v} - v_g)}{V} \ldots (3b)$$

In the preceding discussion the size v_g has been considered as composed of pieces, all of which have an identical volume. In general industrial practice, a range of sizes (for instance, $1\frac{3}{4}$-in. to $2\frac{1}{4}$-in. coal) is often considered as a single size. In case the v_g-size consists of a range of sizes from

v_{g1} to v_{gn}, σ_g is evaluated as follows:

Subdivide the v_g size range as closely as desired to obtain fractions within which the volume per piece may be considered constant, thus obtaining:

G_1 = per cent by volume of size having volume v_{g1},

G_2 = per cent by volume of size having volume v_{g2},

. . . . . .

G_n = per cent by volume of size having volume v_{gn}.

Then

$$G = G_1 + G_2 + \ldots + G_n \ldots (13)$$

The contribution of the square terms and the external cross-products to σ_g^2 will obviously remain the same as in the previous case where the v_g size was a sharply limited one. The contribution of the internal cross-products is evaluated below.

In the N samples there will be close to $\left(\frac{G_1 Nt}{100\, g_1}\right) v_{g1}$ pieces, $\left(\frac{G_2 Nt}{100\, g_2}\right) v_{g2}$ pieces, etc. Also each v_{g1} piece will contribute $g_1(g_1 - 1)$ cross-products and each v_{g2} piece will contribute $g_2(g_2 - 1)$ cross-products. Each of these cross-products will have the value $\left(1 - \frac{G}{100}\right)^2$ since both units in such cross-products are successes. Sizes other than those included in the v_g size will make the same contribution as in the discussion above. Hence:

$$\frac{2}{N}\left(\frac{100}{t}\right)^2 \sum_1^N [d_{i1}d_{i2} + d_{i1}d_{i3} + \ldots + d_{i1}d_{it} + d_{i2}d_{i3} + \ldots + d_{i2}d_{it} + \ldots + d_{it-1}d_{it}] = \frac{1}{N}\left(\frac{100}{t}\right)^2 \frac{Nt}{100}\left\{[A(a-1) + B(b-1) + \ldots + G_1(g_1 - 1) + G_2(g_2 - 1) + \ldots + N(n-1)]\left(\frac{G}{100}\right)^2 + [G_1(g_1 - 1) + G_2(g_2 - 1) + \ldots G_n(g_n - 1)]\frac{100(100 - 2G)}{(100)^2}\right\} \ldots (14)$$

If we define an average volume of piece in the v_g size range by the equation

$$G\bar{v}_g = G_1 v_{g1} + G_2 v_{g2} + G_3 v_{g3} + \ldots + G_n v_{gn} \ldots (15)$$

where $\bar{v}_g$ is this average, we find that the sum of the cross-products takes the same form as in Eq. 3*b* above, except that we substitute $\bar{v}_g$ for v_g. The equation for σ_g when the v_g size consists of a range of sizes is:

$$\sigma^2_g = \frac{G(100 - G)\bar{v}_g + G^2(\bar{v} - \bar{v}_g)}{V} \ldots (3a)$$

where $\bar{v}$ is defined by Eq. 12 and $\bar{v}_g$ is defined by Eq. 15.

If the distribution law for the sizes is known, the sizes may be plotted against the cumulative frequency as in Fig. 8. The quantity $\bar{v}$ is the average height of the curve, and the quantity $\bar{v}_g$ is the average height from v_{g1} to v_{gn}. These quantities can then be determined by graphical integration.

Both sides of Eq. 3*a* may be multiplied by the density if it is the same for all sizes in the aggregate to obtain Eq. 3 of the text.

Laboratory Tests of Protective Coatings *versus* Service Results[1]

By W. T. Moran[2] and G. E. Burnett[3]

SYNOPSIS

How much do laboratory tests mean in predicting service performance of protective coatings? In some cases, it seems they give rather a true picture of what is to come; in others, they provide only part of the answer and the whole story must wait for results obtained in practice. Some of the Bureau of Reclamation's experiences are offered in illustration, with emphasis given to protective coatings for metal work. The authors endorse laboratory testing of protective coatings as a worth-while aid to good engineering, but at the same time see the need for precaution in attempting to draw final conclusions based solely on such testing.

MANY things can be learned quickly in the laboratory concerning the performance of protective coatings on the job. Viscosity determinations and simple brushout tests provide good indications of the facility with which the coating can be applied. Tests for color, gloss, reflectance, and leveling provide a fair representation of what the coating will look like. With reasonable allowance for variations in atmospheric conditions, the time required for proper drying on the job can be estimated with confidence in the laboratory. Where the background of experience is adequate, a reasonable prediction for durability is often possible on the basis of tests for composition. Salt spray and accelerated weathering tests are valuable as screening tests that will quickly weed out ineffective materials, although care must be exercised not to place too much confidence in them.

Most of these tests are used in the routine type of testing employed for deciding the suitability of the more-or-less established protective coatings for wood, metal, and masonry. Many are used to control compliance with specifications. The value of such testing as a means of predicting service results is being given increasing recognition by manufacturer and user alike. A good example of this is the emphasis that has recently been given to the testing of paints by the Bureau of Federal Supply. In too many cases in the past, delivered paints simply have not proved to be what the user had a right to expect from the specification requirements. Within the limits possible from short-term laboratory tests, the user is assured of good performance and value received. At the same time, the manufacturer is protected against unfair competition wherein an unreasonably low bid is submitted with the expectation of supplying material that does not comply with specifications.

The Bureau of Reclamation for many years has made a practice of testing the paints used in its work. There are few who question the value of this testing. It pays off in better, more durable paint jobs, with a corresponding decrease in project maintenance costs.

TESTING FOR SPECIAL SERVICE CONDITIONS

Protective coatings for use under special service conditions often demand a more thorough laboratory investigation than is normally required. A miscellany of tests that purport to predict the utility of coatings in various specialized services are described in the literature. Examples range from simple

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] This paper was presented at the First Pacific Area National Meeting of the Society, held in San Francisco, Calif., October 10 to 14, 1949.

[2] Head, Chemical Engineering Section, Branch of Design and Construction, Bureau of Reclamation, Denver, Colo.

[3] Head, Paint Laboratory, Branch of Design and Construction, Bureau of Reclamation, Denver, Colo.

immersion tests for resistance to chemicals and solvents to some rather complicated procedures, such as those described for estimating the effects of electro-endosmosis in the deterioration of paint films. Some of these tests do provide reasonably accurate predictions of performance in actual service; others fail to do so. Sometimes a necessary service requirement is overlooked in the laboratory, and the value of a large amount of testing that points to favorable performance is largely lost. An example of this can be taken from Bureau experience.

Oversight in Testing:

In 1940, the Bureau was confronted with selecting a suitable protective coating for the eleven 135 by 28-ft. spillway drum gates of the Grand Coulee Dam. The gates would be subjected to long periods of continuous flow of water. At times portions would be exposed to sunlight. Debris would scrape over the surfaces, and good opportunities for maintenance painting would be few and far between.

About this time the Army Engineers had made substantial progress in an exhaustive laboratory study coupled with field tests of protective coatings for similar service on gates of dams of the Mississippi River.[4] A large number of coatings and coating systems had been tried out. In the laboratory, tests were made for ability to protect against corrosion in salt water and tap water, and for resistance to sand abrasion. Studies of the effects of rust-inhibitive pigments in prime coats, of pretreatments for the metal surfaces, and of sand reinforcement were included. Test specimens were also exposed directly in the river. After segregation of the most promising coating systems on the basis of these tests, applications were made on selected gates of the dams. The best performance in both laboratory and field tests was realized with the following system: (1) cleaning by sandblasting; (2) pretreatment with a phosphoric acid – chromate solution; (3) priming with a phenolic vehicle zinc chromate – aluminum paint; (4) incorporating sand in a second prime coat of the same type of paint; and (5) applying two coats of a phenolic vehicle aluminum finish paint.

So far as was apparent at the time, service conditions at the Grand Coulee Dam would closely duplicate the conditions for which this protective coating system had proved outstanding. Because of the comprehensive nature of the Army Engineers' investigations, testing of this paint system in the Bureau's Paint Laboratory was limited to control tests of delivered paint materials.

The protective coating was duly applied in accordance with recommended procedure, and made a fine-looking job. Then developed the rub—and this may be taken almost literally. In the operation of these drum gates, the downstream skin plates rub over spring metal seals. The scraping and gouging action of these seals proved too much for the coating, and considerable damage resulted.

It had been realized, of course, that spring seals do not bear on the skin plates of tainter and roller gates, which were the types installed in the Mississippi River dams and for which the coating was designed. The effect of the seals on the coating, however, had simply not been thought of as being a significant factor in the face of the over-all corrosion prevention problem. Thus, laboratory tests that might have predicted this sort of damage had not been made.

As a matter of fact, probably no coating would have been able to resist the action of these particular seals. A different alloy that permits proper functioning with considerably less pressure on the gate surface has been used since by the Bureau in the fabrication of seals for drum gates. At the same time, as an added safeguard, the protective coating for this service has been changed to a vinyl resin formulation, which has proved to be more resistant to the action of spring seals and so far appears to be the equal of the sanded aluminum paint system in resistance to sun and water.

Inadequacy in Test Procedure:

Sometimes a test procedure that apparently has answered a question in field performance for some time suddenly becomes inadequate. An illustration of this can be taken from the Bureau's experiences with coal-tar enamel, a widely used protective coating for submerged and buried ferrous metal work. When the Bureau decided to use this coating for the protection of steel penstocks and outlet pipes, it was decided at the same time to take advantage of the current American Water Works Association Specifications[5] covering the coating materials and their application. These specifications are comprehensive and include a variety of performance tests designed to establish the suitability of the coating in service.

Of particular interest to this discussion is the "peel test," which requires that the enamel, as applied over a suitable coal-tar primer, be tightly adherent to the surface of a sandblasted steel test plate at temperatures of 80, 100, 120, 140, and 160 F. These temperatures cover the warm end of the range of pipe temperatures that can be expected when the pipe is exposed on the job, and since any tendency for enamel to peel becomes exaggerated when it is warmed, the test would appear to provide a sound indication of whether the coating can be expected to adhere properly in practice.

It was disconcerting, therefore, when after having found the enamel coating materials for one of our jobs last year to pass all laboratory tests, it was observed that the coatings on delivered pipe sections were not properly bonded. Careful investigation disclosed nothing wrong with the manner in which the cleaning and coating work was being performed. It was found that the enamel actually was tightly bonded directly after application and for a few days thereafter, but then adhesion deteriorated. This factor was not weighed in the laboratory because, in accordance with the specified procedure, the peel test was made directly after preparation of the test specimen.

So far as known, this was a first for such an occurrence. Previous experience had indicated that if properly bonded initially, coal-tar enamel would stay bonded (barring the effects of extreme cold), and the control test was based on this supposition. In the light of this new development, an investigation was made to see if a revised laboratory test could be devised that would predict lasting adhesion. It was found that latent peeling would develop on test plates prepared with these same coating materials when exposed outside to the heat of the summer sun. It was found also that with certain other primers, the peeling tendency would not develop. However, there is not always a warm summer sun handy, and a practical control test requires the use of equipment and conditions that can be duplicated in laboratories everywhere. In searching for this practical test procedure, it was determined, at least tentatively, that storage of the test specimen in an oven at 160 F. would also reveal latent peeling tendencies. The Bureau now requires "no peel" in a laboratory test of enamel after 3 days' exposure at 160 F., in addition to the regular A.W.W.A. requirements. It is

[4] The completed study is covered in "Report on Protective Coatings for Lock and Dam Structures—Upper Mississippi River, September, 1947," issued by Upper Mississippi Valley Division, Corps of Engineers.

[5] A.W.W.A. Standard Specifications (7A.5-1940) for "Coal-Tar Enamel Protective Coatings for Steel Water Pipe of Sizes 30 in. and Over," and (7A.6-1940) "Coal-Tar Enamel Protective Coatings for Steel Water Pipe of Sizes Up to But Not Including 30 in."

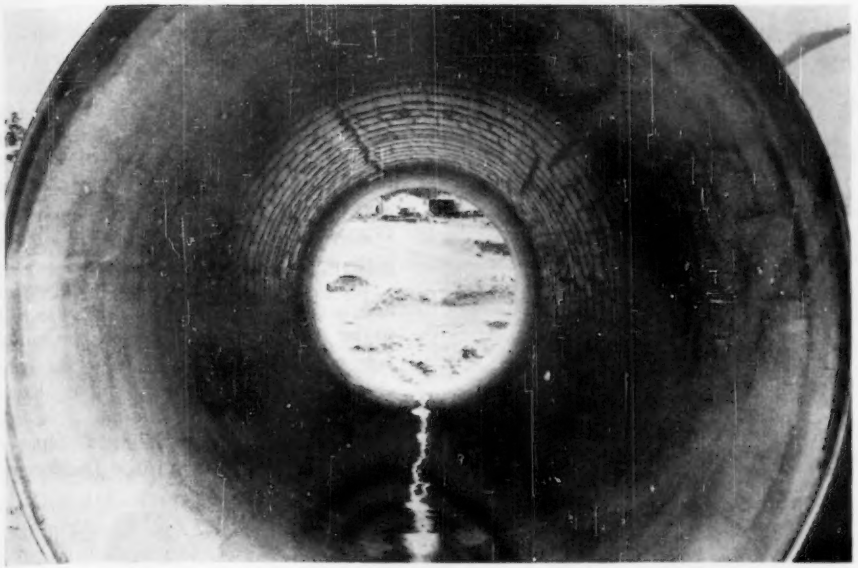


Fig. 1.—Coal-Tar Enamel Lining Having a Penetration of 7 Is Intact Even Though Exposed to Temperatures Ranging Down to —25 F.

believed that by so doing an inadequacy in laboratory testing will have been corrected.

Inadequacy in Setting Proper Limits:

Sometimes the test procedure may be appropriate, but failure in service results from not setting suitable specification limits on the basis of the procedure. Experiences with coal-tar enamel can again be used in illustration.

Any construction material has its limitations. Coal-tar enamel is no exception. One is that it can stand only so much cold without becoming so brittle that it will crack and disbond. The A.W.W.A. specification mentioned previously attempts to cover this point in several ways. One is to require a certain degree of plasticity in the material by means of setting a lower limit on penetration.[6] Since the more plastic the enamel the less is its tendency to crack and disbond at low temperatures, the test itself may be considered appropriate. The question at issue is in setting the requirement for the lower limit.

The A.W.W.A. specification writers had set a minimum penetration of 7 at 77 F. By implication from other test requirements, an enamel having this penetration, and being otherwise satisfactory and applied properly over a good primer, should be able to resist —20 F. without cracking and disbonding.

It is true that enamel of 7 penetration is reasonably plastic at room temperature; it can be easily indented with the fingernail. However, in the process of heating for application, the hardness of the enamel increases. If the heating is very carefully performed, the penetration of the enamel on the pipe may be 4 or 5. It is more likely that it will be about 2. With this hardness at 77 F., the enamel becomes glasslike at subzero temperatures. When pipe lined with such enamel is exposed above ground, it simply does not have enough plasticity in cold weather to accommodate differential expansion in the steel outer shell, and cracking and disbonding ensue.

[6] Standard Method of Test for Penetration of Bituminous Materials (D 5 – 49), 1949 Book of A.S.T.M. Standards, Part 3, p. 1078.

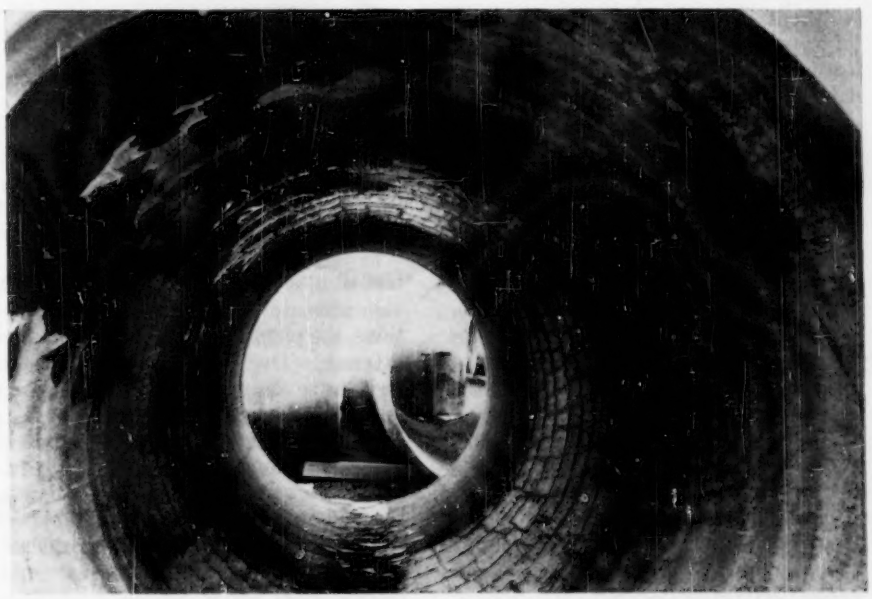


Fig. 2.—Coal-Tar Enamel Lining Having a Penetration of 2 Has Cracked and Become Partially Disbonded as a Result of Exposure to Temperatures Ranging Down to —25 F.

Last winter, enamel-lined pipe, as furnished on two separate contracts, was exposed at the same job site where the atmospheric temperature dropped to —9 F. In the one case, the enamel had an initial penetration of 8 and the average on the pipe was 2. This enamel cracked and spalled from nearly half of the pipe. In the other case, the enamel had a penetration of 15 initially and averaged about 7 on the pipe, and there was no cracking or spalling whatever. On another job, enamel of about 7 penetration after application survived shipping and open storage in temperatures that went as low as —25 F. with less than 1 per cent of the total coating damaged. What damage there was could be correlated with excessive hardness of the coating (see Figs. 1 and 2).

As a result of these experiences, we now require penetrations of not less than 13 for enamel as furnished and of not less than 7 after application. By doing this, it is believed that the laboratory test becomes much more indicative of what can be expected in service.

Duplicating Service Conditions in the Laboratory:

It is apparent, of course, that the nearer the laboratory test can come to duplicating service conditions, the more informative it will be in predicting service performance. For example, it is preferable to judge brushing characteristics, leveling, and general appearance of a flat wall paint on 8 sq. ft. of wallboard than on, say, a 3 by 5-in. tin panel. This factor is something that should always be borne in mind in designing tests for the purpose of predicting service performance of protective coatings.

A few years ago, tests were made in the Bureau laboratories for the purpose of establishing a suitable coating for inhibiting algae growth on concrete canal linings and flumes. The tests were made by introducing live algae into

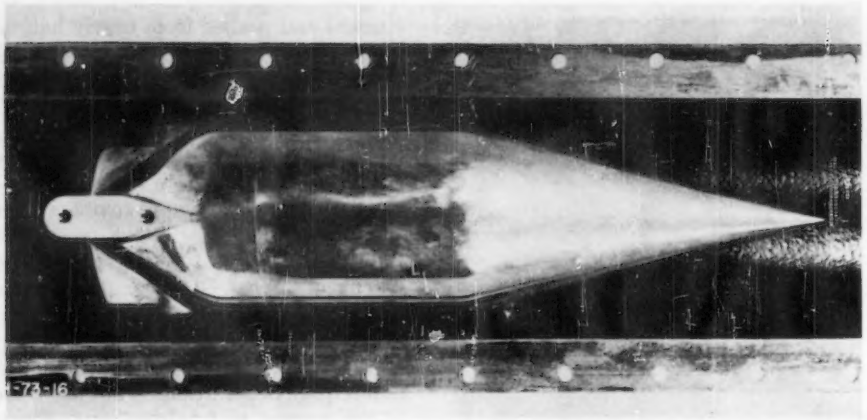


Fig. 3.—Apparatus for Determining Resistance of Protective Coatings to Cavitation Erosion. Brass Specimen Illustrated. Flow from Left to Right.

tap water contained in concrete crocks lined with various toxic coatings. The most effective coatings, which definitely killed all algae growth in these tests, consisted of powdered copper or powdered cuprous oxide held in a portland cement paint film. Some of the others retarded the growth and some had no effect whatever. A field trial was subsequently arranged on a concrete flume of the Minidoka Extension Canal in Idaho, using the copper-portland cement coating.

Inspection after trial through one summer's irrigation season revealed that the coating was completely ineffective; the treated test section had the same amount of algae growth as an adjacent untreated section. The flow of water through the flume was the factor which had not been considered in the laboratory tests. Its effect was twofold. It diluted the concentration of copper ion at the surface of the coating and resulted in a heavy deposit of carbonates on the surface, the combination of which virtually eliminated the potential toxicity of the coating.

As an example of effort made to duplicate service conditions, it is believed appropriate to discuss the apparatus (see Fig. 3) which is used in the Bureau laboratories for studying the effects of pitting due to cavitation on the service life of protective coatings. Cavitation erosion is caused by the mechanical impact of collapsing vapor pockets when water flows at high velocity past an irregularity in the surface of the confining structure. It is often encountered in certain parts of hydraulic turbines and outlet valves. To be of good service in protecting such areas from corrosion, a coating must first be able to withstand these cavitational forces.

Most coatings will not last long where cavitation erosion exists. This has been proved in practice and is borne out in tests conducted on the Bureau apparatus. Figure 4 shows some typical

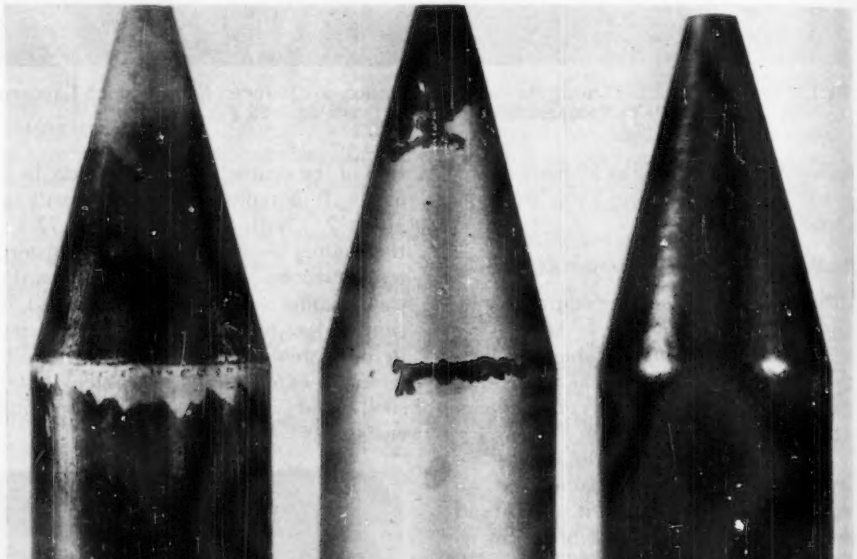


Fig. 4.—Typical Performance of Protective Coatings in Cavitation Erosion Test at Velocities of 85 to 95 ft. per sec.

Coal-tar paint at left under test 6 hr. Vinyl resin paint in middle under test 14 hr. Unaffected neoprene coating at right under test 18 hr.

test results. It will be noted that test velocities are high. Under such conditions, the pitting effect on the cone tip is extreme. The best coatings in these tests have proved to be those having unusually high resiliency, such as neoprene and thiokol synthetic rubbers. The neoprene coating illustrated was virtually unaffected in the test, whereas the cold-applied coal-tar paint and vinyl resin paint, both of which are considered to provide good protection for submerged steel under normal conditions, are damaged badly.

It would be premature to give too much weight to the belief that this laboratory test is one that will always give the correct answer as far as resistance to cavitation erosion is concerned. However, it can be said that a neoprene coating applied to the gates of turbines of the Marshall Ford Dam was reported to be as good as new after 8 months' service, whereas other coatings had failed consistently in a much shorter time.

Service Tests

It is good engineering practice to try out coatings that have shown promise in laboratory tests in small scale field tests before embarking on full scale service applications. This can often save considerable embarrassment to the laboratory prognosticians.

For example, in our laboratory certain synthetic resin vehicle paints had looked quite promising for the protection of submerged steel and were being considered for use in lining pipe. However, when included in some field test applications in one of the outlet pipes of the Grand Coulee Dam, they performed quite considerably less effectively than several other coatings, notably coal-tar enamel, a cold-applied plasticized coal-tar pitch paint, and a vinyl resin formulation, over a 6-yr. period.

Even the results of service tests must be viewed with caution. Witness our earlier remarks about coal-tar enamel. In the Grand Coulee tests, where this coating survived virtually unaffected, it was not subjected at any time to subzero temperatures. From the conditions at Grand Coulee to open exposure in winter weather in cold climates was too great a jump, at least with no modifying provisions to insure a more plastic material.

Early this summer, a number of the most promising developments in protective coatings for submerged steel were applied as test coatings to one of the penstocks of the Shasta Dam Power Plant in California. Included were

flame-sprayed thiokol, sprayed metals, liquid synthetic rubber coatings, microcrystalline wax, phenolic and vinyl resin coatings, and a U. S. Navy hot-applied plastic formulation. All will be compared with the performance of coal-tar enamel used on all except the test sections. It will be interesting to see how these behave in comparison with their performance in laboratory tests. It will be interesting also, providing any show superior performance to the coatings presently in use for this service, to see if the jump from field test to full scale use will introduce unforeseen difficulties.

Application Problems

The job does not end with the laboratory's investigation of materials and its recommendations as to what to use and how to apply it. The most carefully planned laboratory work will go for naught if attention is not given to seeing that its recommended procedure is followed with painstaking thoroughness on the job.

Protective coatings are no different than other engineering materials in this respect. They must be handled intelligently, with due allowance for their limitations, if best service is to be realized from them. As a matter of fact, protective coatings somehow seem to come in for more than their share of mishandling, and usually little weight is given to excuses made for them on the basis of improper usage on the job. It therefore behooves laboratory people to make every effort to see that any potentially successful results of their hard work are realized in practice by following through on field application.

Conclusion

In review, it may seem that this paper is overly pessimistic concerning the value of laboratory testing in predicting service performance of protective coatings. Stress has purposely been laid upon its shortcomings rather than upon its strong points, because therein lies the greatest opportunity for improvement. That laboratory testing is an indispensable phase of good engineering is unquestioned, but blind reliance on the results of laboratory tests alone may frequently lead to trouble.

DISCUSSION

Mr. R. B. Diemer[1] (*presented in written form*).—The authors of the paper on Laboratory Tests of Protective Coatings *versus* Service Results have covered the subject very thoroughly. My discussion will deal only with the experience of the Metropolitan Water District of Southern California with coal-tar enamel for protective coatings on the inside and outside of welded steel pipe.

It is our opinion that excellent service results can be obtained with coal-tar enamel coatings only when proper application methods are followed in the field by competent workmen who are experienced in applying primer and coal-tar enamel and properly supervised by inspectors who are thoroughly familiar with the requirements for this type of protective coating.

The Metropolitan Water District of Southern California maintained a testing laboratory at Banning, Calif., throughout the construction period on the Colorado River Aqueduct extending from 1933 to 1939. Although the work of the laboratory force was principally testing of materials for concrete construction, a course of instruction was given at the laboratory to all engineers and inspectors before they were assigned on the aqueduct for supervision of concrete work. In this way the inspectors became familiar with laboratory work, studied the specifications, and were better able to obtain service results comparable to laboratory tests in the execution in the field. If this practice could be followed on a large job where protective coating of coal-tar enamel is required, better results would be obtained. Laboratory tests may reveal that the product offered by the manufacturer complies with the specifications but poor application partially due to inexperienced workmen or to inexperienced inspectors may result in a poor service performance.

During the period of construction of the aqueduct in 1936 and 1937, 10 miles of welded steel pipe with an average diameter of 11 ft. was constructed across the Santa Ana River near Arlington, Calif. With the exception of about 1000 ft., all of this pipe was laid in trench and covered. The thickness of the steel plate varied from $^{17}/_{32}$ to $^{31}/_{32}$ in. The hydraulic head on the pipe varied from 250 to 480 ft. The District specifications required that the interior of the pipe be covered with a coating of coal-tar enamel $^{3}/_{32}$ in. thick either by hand daubing or by spinning. The method of application was to be left to the option of the contractor because of the uncertainty as to whether any of the bidders would attempt spinning pipe of such sizes and weights. The largest pipe with spun lining made prior to this project was 78 in. in diameter. Equipment was developed by the contractor which successfully spun the lining. Subsequent specifications of the District required spinning of all straight sections of steel pipe. Samples of the coal-tar enamel for each shipment were tested at the Banning Laboratory before the material was allowed to leave the manufacturer's plant. After the pipe had been fabricated and tested hydrostatically, it was grit-blasted in a completely automatic plant. It was then immediately primed by spraying. While under some weather conditions less drying time would have been satisfactory, experience indicated the desirability of standardizing on a minimum drying time for the primer of 24 hr. Experience and tests showed that the bond of enamel to primer was impaired if too long a time elapsed between application of the two materials. Repriming was required when enameling was delayed more than 72 hr. after priming. Strict inspection required reblasting the pipe to bright metal and repriming if the primer had been poorly applied or if rusting appeared. It was found desirable to preheat the pipe to a temperature 190 to 200 F. before spinning because of the unusual thickness of the steel plate. Otherwise the relatively small volume of heated enamel with respect to the large volume of cold metal would not allow the temperature of the high-melting-point primer to rise high enough to provide a satisfactory bond between enamel and pipe at all temperatures.

The specifications required protective coatings on the exterior of the pipe as follows: For moderately corrosive soils, a $^{3}/_{4}$-in. coat of gunite; and for highly corrosive soils $^{3}/_{32}$-in. coal-tar enamel with an armor coat of $^{3}/_{4}$-in. gunite. The exterior coating of enamel was applied immediately after the inside coating had been spun; the pipe, while still hot, was transferred from the spinning machine to adjacent rollers where the outside enamel was applied by a wide-mouthed spout and wiper attached to an extension pipe mounted on the end of a movable boom while the pipe was slowly rotating. After the pipe had been tested for "holidays" in the enamel, a coat of $^{3}/_{4}$-in. gunite (reinforced with a 2 by 4-in., No. 12-gage, galvanized wire mesh) was applied over the enamel. Considerable care was necessary in applying the wire mesh and gunite to the outside enameled pipe to prevent injury to the enamel. This work was done at temperatures below 60 F. so that the wire mesh would not penetrate the enamel.

Special sections involving curves and elbows together with field joints in the

[1] Operation and Maintenance Engineer, The Metropolitan Water District of Southern California, Los Angeles, Calif.

pipe were hand daubed. This type of application required very strict inspection to obtain satisfactory performance of the enamel.

The methods followed by the District in the application of coal-tar enamel for both the interior and exterior coatings have successfully passed the test of service for the past 10 years since the aqueduct has been in operation. No repairs have been necessary in any part of the 10-mile pipe line. Coordination of the laboratory force together with the cooperation of the manufacturer's representatives and the inspection at the plants plus the desire of the steel contractors to do a good job resulted in satisfactory performance to the District on this pipe line which cost approximately $4,750,000.

In 1942 and 1943 the District reclaimed a 36-in. welded steel pipe line which had been installed by the City of Pasadena in 1934. This pipe line of $\frac{1}{4}$-in. and $\frac{5}{16}$-in. welded steel plates, 11 miles in length, had been lined internally and externally with a dipped asphaltic coating. The external coatings were found to be in poor condition when the pipe was removed from the trench. Regardless of what specifications had been used for the coating materials, or what laboratory tests had been made, service results were not satisfactory due to lack of adequate means to protect the external coating from soil stresses and other damaging effects. Tree roots had penetrated the lining and left exposed places on the pipe. Where the pipe was in gravel or rock, many ruptures were found in the coating. Although the pipe had been in service only about eight years, the exterior showed appreciable pitting. Most of the pits were in the bottom of the pipe where the coating had been punctured by rocks and boulders. This pipe was reconditioned after removal from the trench, the old coatings were removed by burning and shotblasting, pits $\frac{1}{16}$ in. or greater were welded and the weld material ground off to the face of the plate so that a uniform thickness of enamel could be applied. An average of six pits per section was found in 1878 30-ft. sections. This reveals a poor service record even though the protective coating may have been considered satisfactory at the time the coating was applied.

Coal-tar enamel exterior coatings without a protective coat of gunite or mortar may not be satisfactory even though laboratory tests show that the materials meet all the specification requirements and inspection requires proper application of the material. The District's experience gained on the Santa Ana siphon was reflected in the satisfactory service obtained on interior and exterior coatings applied on the above-mentioned 11 miles of reclaimed pipe. There has been no apparent damage to the coatings after five years of operation.

In addition to this type of protection, the District has 52 miles of welded steel pipe, diameters varying between 24 and 55 inches with $\frac{1}{2}$-in. spun mortar lining. Inspection of lining recently shows that the steel has had excellent protection.

The District's experience with coal-tar enamel seems to bear out Moran and Burnett's statement, "Protective coatings must be handled intelligently, with due allowance for their limitations, if best service is to be realized from them."

MR. G. H. GARRETT[2] (*presented in written form*).—This paper deals with a subject quite frequently overlooked. The reproduction of actual field conditions in a laboratory test or in a sample field test is of vital importance when trying to evaluate the qualities of any protective coating.

Since these men are engaged in laboratory testing, they are to be congratulated for their forthrightness in preparing a paper such as this, which points out the weakness of ordinary laboratory testing procedures.

We should like to see more stress laid upon the fact that rigid specifications for field application procedures must be adhered to strictly. It is equally as undesirable for the work in the field to be done without compliance with specifications as it is for the laboratory tests and conclusions to be made with conditions unlike the field conditions.

As a manufacturer of steel pipe for water service, the writer has had more experience with the coatings of pipe than other phases of protective coatings. The authors' remarks regarding their experience with coal-tar enamel are especially interesting.

They have done some fine work in correlating the penetration with ability to stand severe cold temperatures. However, proper care and handling of the pipe during transportation and installation still must be exercised in order to insure as good quality as possible for the protective coating after its installation.

Any mishandling of coal-tar enamel products that would produce stresses beyond those produced in the testing laboratory, could very well produce coating failures that would not be anticipated in the testing laboratory.

The authors do state that "It behooves laboratory people to make every effort to see that any potential successful results of their hard work are realized in practice by following through on field application." More emphasis could be placed on this requirement, particularly, where somewhat flexible structures are involved, such as large diameter pipe.

MR. E. R. STAUFFACHER[3] (*presented in written form*).—The authors are to be congratulated on their lucid presentation of a subject which must always be considered when a new protective coating is presented by the manufacturer and where large scale applications of such coatings are under consideration.

The more thorough the laboratory testing the greater reliance can be placed on expected performance in service. However, it appears to be almost impossible to anticipate in the laboratory all of the unusual conditions which might arise, and for this reason it is necessary to extend the investigation beyond the laboratory before a certain untried protective coating can be accepted for widespread service. To this end the process for determination of a suitable and effective protective coating generally requires: (1) an investigation of its properties in the laboratory and its suitability as determined by artificial weathering or salt spray tests; (2) outdoor exposure tests using metal (usually ferrous) panels which have been prepared in the laboratory and where the coating has been applied in the laboratory (this procedure would apply also to wooden panels where protection for exterior wooden structures is involved); (3) the use of a small-scale pilot or experimental installation on certain equipment in the field, applied under field conditions and by the maintenance workmen; and (4) a large scale application throughout a power plant or substation or possibly on a group of structures having rather rigorous exposure. Only after a protective coating has gone through these successive steps and proved its durability can it be considered for general application throughout a power system. Even then, the various conditions of service to be met and conditions under which it must be applied may require modification of the protective coating from time to time.

The above procedure may appear to be rather time consuming, and so it is, but it seems to be the only way that one can be assured that the coating will protect under the conditions which it must face. Probably the most crucial test is the third one referred to above, namely, the small scale experimental field test applied under field conditions. At this stage the laboratory should be in close touch with the field work so as to note the conditions under which the coating must be applied. By observation of these conditions, the laboratory will be able to devise methods of testing which may shorten the over-all time required for an extensive investigation of a new

[2] Vice-President, Thompson Pipe and Steel Co., Denver, Colo.

[3] Electrical Engineer, Southern California Edison Co., Los Angeles, Calif.

coating. When competitive coatings are being compared, the laboratory and panel exposure tests are of extreme value in screening out coatings which obviously do not have the required ruggedness for the anticipated service. It has been often said that not much time is required to find out which are the poorer or unsuitable coatings, but it does take considerable time to determine which is the best. In practice it usually works out that several coatings appear to have almost equal merit, and the investigation must be continued with these more suitable coatings until two or three of them prove to be acceptable for use throughout a power system.

The authors' account of their experiences in finding field conditions and service requirements somewhat different than anticipated illustrates the necessity for careful field observations at all times. The laboratory should be informed promptly regarding any deficiencies which develop so as to take care of these deficiencies in future laboratory tests. The experience of the authors in regard to the laboratory tests of coal-tar enamel under a nationally accepted specification as compared to the deficiency of the material in a particular service is a good example of the necessity for close cooperation between the laboratory and the field. In their case a revised laboratory test was adopted which corrected an inadequacy in the testing. The authors deserve our thanks for bringing this point to our attention. A revised specification covering the points which the authors have described should be of benefit to all users of coal-tar enamel.

Even with careful thought before beginning a job, supplemented by exposure tests, a protective coating may fall short of its expected performance due to conditions of application. In the case of steel transmission line towers traversing a heavy industrial district in the coastal area, it was found that a protective coating was required after about fifteen years service even though the steel members had been galvanized originally. Accordingly, studies were made of various combinations of primers and finish coats, and steel panels coated in the laboratory were exposed at the site where the coating was to be applied. After a few years exposure the decision was made as to the acceptable coatings which incorporated a medium slow drying primer as the first coat. When applying the coating in the field, the slow drying primer was used and a minimum of 48 hr. drying time was allowed before application of the top coat over the primer. It was found that although this particular coating system gave fair service it did not hold up as well as should have been expected from the performance of the coating on the exposure panels. It was noted later that deposits made up of dust and possibly particles from industrial chemicals in the air together with fog from the seacoast would collect on the tower members. During the interval between the application of the primer and the top coat, short as it was, a small amount of this contaminating material would deposit on the prime coat. Even though attempts were made to wipe or brush off the contaminating deposit, a certain amount of it would become incorporated with the top coat. It was surmised that the deposit was, in a large measure, responsible for the performance of the coating not being up to expectations. Accordingly the coating specification was revised to utilize a quick drying primer (about 4 hr. drying time) incorporating substantially the same inhibitive ingredients, and the painting routine was changed to the extent of applying the top coat as soon as practicable after the primer had dried. Quite often it was possible to apply the primer and top coat the same day even though a comparatively thick brush coat was applied in each case. Since this change in primer and application routine, the protective coat appears to be performing better in the worst locations, although the service record of the modified coating to date is only about one year.

Laboratory testing should become more valuable as new methods of investigation are devised, provided that the laboratory is promptly informed of results in the field. As the laboratory becomes better acquainted with the field conditions, the preliminary tests in the laboratory may shorten the time for field investigation. Until that time, however, it must be a case of laboratory and field testing working together to the end that the hoped-for service results will be achieved. This discussion would not be complete without a tribute to the coating manufacturers for their assistance in helping to solve the various problems which develop in the field. Whenever a condition has been brought to their attention they have wholeheartedly cooperated to help overcome any deficiency in their coating and to assist in the proper application procedure.

MR. R. G. LANDIS[4] (*presented in written form*).—Although Messrs. Moran and Burnett make no distinction, there are two categories of laboratory tests. One includes those tests necessary to develop a satisfactory product to meet the customer's requirements, and the other includes the tests necessary for the satisfactory control of that product once it has been approved and put into production.

Tests necessary in the development of a product varying in complexity depending on the final end use of the material. The more background a formulating group has on a project, the less complex the tests need to be. Certainly the amount of testing required to develop a toy finish where no long durability is expected is not as great as that required in the formulation of an interior water-tank finish.

By the same reasoning, the control tests, once the product is developed, need not be as complex for the toy finish as for the water-tank coating. Perhaps color, gloss, drying speed, and print resistance would be adequate for the former, whereas, the latter would have to embrace a more time-consuming procedure involving water immersion, cold-checking, etc. While a house paint might consume hours and hours of initial testing and retesting and even months of exposure before it was adopted, the actual control testing would have to be streamlined, since a production schedule would probably call for a tank turnover at least once every three days, if not oftener.

While it is evident the paper reflects a pessimistic viewpoint, it must be remembered that the authors are associated with construction involving millions of dollars, and the projects are not always accessible for periodic maintenance. In such cases the laboratory testing must duplicate as nearly as possible field results.

We find similar instances in other paint applications where equal caution in evaluating laboratory results is desirable. For instance, despite the many tests for abrasion resistance, such as Taber, falling sand, and others, it is not generally conceded that traffic paints can be completely evaluated except by making comparative field tests. Most testing laboratories and procurement agencies paint out strips across a street or highway, making comparisons against products of known performance. The use of the test instruments do give some indication of the probable service life, but the results do not always give a direct parallel to actual field conditions.

Likewise, in the testing of paints and enamels there are many laboratory instruments designed to accelerate and duplicate field conditions. Many of the Federal specifications published in TT-P-141b, section 600, are geared directly to some aspect of coating life. Likewise, some A.S.T.M. specifications for paint, varnish, and lacquer are designed to predict varied service conditions. One of the most controversial tests is conducted

[4] Director, Oakland Laboratory, The Sherwin-Williams Co., Oakland, Calif.

with accelerated weathering machines. Many gallons of paint have been rejected on Specification TT-P-489 because of failure to pass tests using the National Carbon machine, while the same paints will pass when tested with the Atlas Twin Arc Weatherometer.

Van Loo[5] pointed out a tremendous advance in testing of house paints during the past 25 years. He emphasized the necessity of pilot plant testing on exposure farms for this type product. No known laboratory tests can predict all phases of service life for long oil finishes.

Elm[6] also covered this subject and proposed a method for reducing the exposures necessary to produce satisfactory results. The proposed values may be analyzed by statistical means.

Moran and Burnett indicated a shortcoming of laboratory testing with respect to the "peel test" on bituminous coatings. This parallels the problem existing in all physical test methods for paint, namely, how long should a finish age and under what conditions before being subjected to tests? An example of this is a product which our laboratory formulated for a station paint. It contained as a vehicle 52-R-13 alkyd lengthened with linseed oil. When subjected to accelerated tests by exposing the film to intense ultraviolet radiation, the finish degraded to a very low gloss in a relatively short time, yet on exterior exposure, the film remained glossy for months. Too short a drying time existed after the panels were prepared. The ultraviolet light apparently irradiated the oil to the point of decomposition before it had a chance to dry.

The subject of oversight in testing certainly is tied in with past experience. Everything cannot be predicted. To minimize oversights, the project should be considered in a logical sequence. The following might be typical, assuming that the protective coatings had been established with adequate raw materials:

1. Package consistency.
2. Reduction, if any, and with what type of solvent.
3. Application technique—brush, spray, dip, flocoat, etc.
4. Surface on which product is applied—type, prepainting treatment, etc.
5. Physical conditions under which product will be applied—temperature, humidity, etc.
6. Drying time—air dry, force dry, bake.
7. Conditions after drying—immediate exposure, temporary storage, packing for shipment, etc.
8. Actual service conditions—weathering, abrasion resistance, impact, etc.
9. Total service life—how long should the product be expected to give satisfactory protection?
10. Maintenance and inspection during life—ease, frequency, etc.
11. Circumstances to be considered in repainting the product—self-lifting, adhesion of subsequent coatings, probability of film failure when recoated (such as recoating with a long oil finish over shorter substrate).

The foregoing illustrates a typical line of reasoning to minimize oversights in testing. Obviously some things are unpredictable, as Moran and Burnett have pointed out.

Likewise, the inadequacies in test procedures and the setting of proper limits can only be achieved with long background in the field. Once the procedures and limits have been established, the material can be kept up to standard only by the use of adequate printed forms which leaves nothing to the memory of the tester.

The duplication of service conditions in the laboratory is largely dependent upon the economic aspects of the situation. The advantages perhaps are in favor of Government agencies, then large companies, followed by small producers. Evidence of this are the very excellent laboratories of the Bureau of Reclamation in Denver and those at Mare Island Navy Yard here in the Bay Area. Within any one group, of course, the duplication of service conditions must be dependent upon the type and volume as well as the dollar value of the coating.

Most producers of protective coatings, test laboratories, and suppliers of the raw material components are becoming increasingly aware of the necessity for more adequate control testing to insure proper quality, and thus reduce service failures and complaints.

MESSRS. W. T. MORAN AND G. E. BURNETT (*author's closure*).—The importance of following through on the job to see that protective coatings are applied properly has been emphasized by the discussers, and bears repeating here. Certainly this is essential to the success of any painting work as well as to intelligent interpretation of laboratory test results in relation to service performance.

We appreciate especially the fact that the discussers have given the reader the benefit of several illustrations taken from their own experiences. We are hopeful that this mutual revelation of difficulties will be an incentive to more careful planning in the testing of protective coatings generally.

[5] Maurice Van Loo, "Twenty-Five Years of Paint Testing," *Industrial and Engineering Chemistry*, February, 1949, p. 267.

[6] A. C. Elm, "Testing the Durability of House Paint Systems for Out-Door Use," *Paint, Oil & Chemical Review*, Vol. 112, No. 10, (1949).

Research Under Way on Riveted and Bolted Structural Joints

A NUMBER of research projects are being carried out at the University of Illinois and Northwestern University on the behavior of riveted and bolted structural joints.[1] This work is under the auspices of a research council on this subject, which in turn is sponsored by several organizations[1] concerned with the problems.

The main object of the council which came into being early in 1947, is to develop specific data to insure safer and more economical design and construction. Currently seven projects are under way covering the effect of bearing pressure on static and fatigue strength of riveted joints, effect of rivet pattern on static strength of structural joints, the strength of rivets in shear and combined shear and tension, fatigue strength of bolted structural joints, the effect of grip upon the fatigue strength of riveted and bolted joints, the fatigue strength of high-strength steel riveted joints, and the effect of rivet pattern on the fatigue strength of structural joints.

Progress reports have been made on the work indicating that much pertinent and interesting data have resulted. In the work on fatigue strength of bolted joints, for example, it is indicated that joints fastened with high-tensile bolts will demonstrate superior values. Some of the data from earlier tests covering hot-and cold-driven rivets and high-strength bolts subjected to fatigue loading are reported in Am. Railway Engineering Assoc. Bulletin 481.

Several A.S.T.M. members are serving on the council or are sponsors of the work. The current chairman is Wm. C. Stewart, Technical Adviser, Industrial Fasteners Institute, Cleveland.

[1] The Research Council on Riveted and Bolted Structural Joints is sponsored by the Am. Inst. Steel Construction, Am. Iron and Steel Inst., Assoc. Am. Rail., Engineering Foundation, Div., Highways, Illinois, Ind. Fasteners Inst., and Public Roads Adm.

Welding Handbook

THE "Welding Handbook" has just been published by the American Welding Society making available to everyone interested in welding perhaps the most complete and authoritative up-to-date single volume on welding.

The book contains 65 chapters covering the more than 30 welding and cutting processes in use by industry today, the welding of ferrous and non-ferrous metals and alloys, and the application of welding in different industries. Also included are individual chapters on cost estimating, welding metallurgy, physics of welding, a dictionary of welding terms, general engineering tables, welding symbols, filler metal specifications, inspection, and many others. A bibliography is included at the end of each chapter listing the important codes, standards, books, and technical articles on the subject of the chapter for those seeking further information.

More than 300 tables are included in the Handbook to make it useful for ready reference and illustrations are generously used to show welding equipment, welding details, and specific applications.

The 69-page index makes it possible to readily find specific information and related information contained in different chapters. Both the index and the text are extensively cross-referenced. Items in the index have been grouped by welding processes, by metals, by applications, and have been further grouped under engineering headings such as design, workmanship, inspection, etc. Each item is also separately listed in alphabetical order.

Copies of the third edition of the 1650-page "Welding Handbook" may be obtained from the American Welding Society, 33 West 39th Street, New York 18, N. Y. The price per copy is $12 in the United States and Canada, $13 elsewhere.

Subsurface Exploration and Sampling of Soils for Civil Engineering Purposes

A FINAL report on "Subsurface Exploration and Sampling of Soils for Civil Engineering Purposes" is now available through the Engineering Foundation. This report presents the results of twelve years of work by Dr. M. Juul Hvorslev on a research project of the Committee on Sampling and Testing of the American Society of Civil Engineers. The project was sponsored by the Engineering Foundation, Harvard University, and the U. S. Waterways Experiment Station, and the report was prepared and printed by the Waterways Experiment Station.

This book is intended as an authoritative reference work on the development and current status of subsurface exploration in general and on sampling of soils and rocks in particular. Its major values to the practicing engineer appear to be:

1. Descriptions and general data for all methods of subsurface exploration and sampling are contained under one cover.
2. The factors influencing the quality of soil samples are clearly and logically delineated.
3. General rules for the design and operation of equipment for obtaining undisturbed samples of various types of soils are presented.
4. A rather complete subject index and an extensive bibliography provide rapid reference to detailed infor mation on most specific topics related to exploration and sampling.

The report, of 520 pages, is divided into two major parts: Part I on "Principles of Exploration and Sampling" contains chapters on general procedures and requirements, methods of subsurface exploration, groundwater observation, sampling methods and requirements, sampling and soil types, disturbance of soil samples, and boring and sampling records. Part II on "Details of Sampling Equipment and Methods" contains chapters on casing and drill rods, open drive samplers, piston drive samplers, special methods and equipment for preventing loss of samples, drive samplers for submarine explorations, core boring methods and equipment, sampling in search of oil and minerals, surface and control sampling, and preservation and handling of samples. The bibliography lists over one thousand references on subjects related to the content of the report.

Copies of this report can be obtained from The Engineering Foundation, 29 W. Thirty-ninth St., New York 18, N. Y.

The price including shipping charges within the United States is $4 for members of the engineering founder societies and libraries and $6 for all others.

Calendar of Society Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS—Spring Meeting, April 19–21, Los Angeles, Calif.

AMERICAN CERAMIC SOCIETY—52nd Annual Meeting, April 23–27, Hotel Statler, New York, N. Y.

AMERICAN FOUNDRYMEN'S SOCIETY—54th Annual Convention and Exhibit, May 8–12, Public Auditorium, Cleveland, Ohio.

AMERICAN INSTITUTE OF CHEMISTS—May 11–12, Hotel New Yorker, New York, N. Y.

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS—Spring Meeting, May 25–27, Hotel Statler, Cleveland, Ohio.

SOCIETY FOR APPLIED SPECTROSCOPY—5th Annual Meeting, May 26–27, Socony-Vacuum Training Center, New York, N. Y.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS—Spring Meeting, June 4–7, Hotel Muehlebach, Kansas City, Mo.

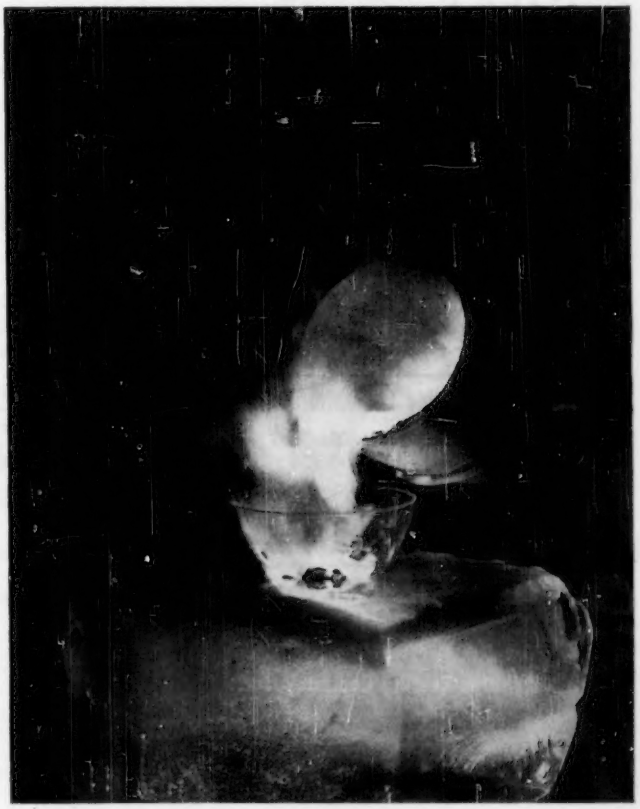
American Society for Testing Materials—53rd Annual Meeting and 9th Exhibit of Testing Apparatus and Related Equipment, June 26–30, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

THE INSTITUTE OF PETROLEUM—Oil Shale and Cannel Coal Conference, July 3–7, Glasgow, Scotland.

AMERICAN CHEMICAL SOCIETY—118th National Meeting, September 3–8, Chicago, Ill.

INSTRUMENT SOCIETY OF AMERICA—Conference and Exhibit, September 11–15, Buffalo Auditorium, Buffalo, N. Y.

NATIONAL PETROLEUM ASSOCIATION—September 13–15, Hotel Traymore, Atlantic City, N. J.



"Devils Tea Cup . . ."

First prize-winning photograph, General Section, General Testing Group in the Sixth A.S.T.M. Photographic Exhibit (1948), by John Kalinich, Corning Glass Works.

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